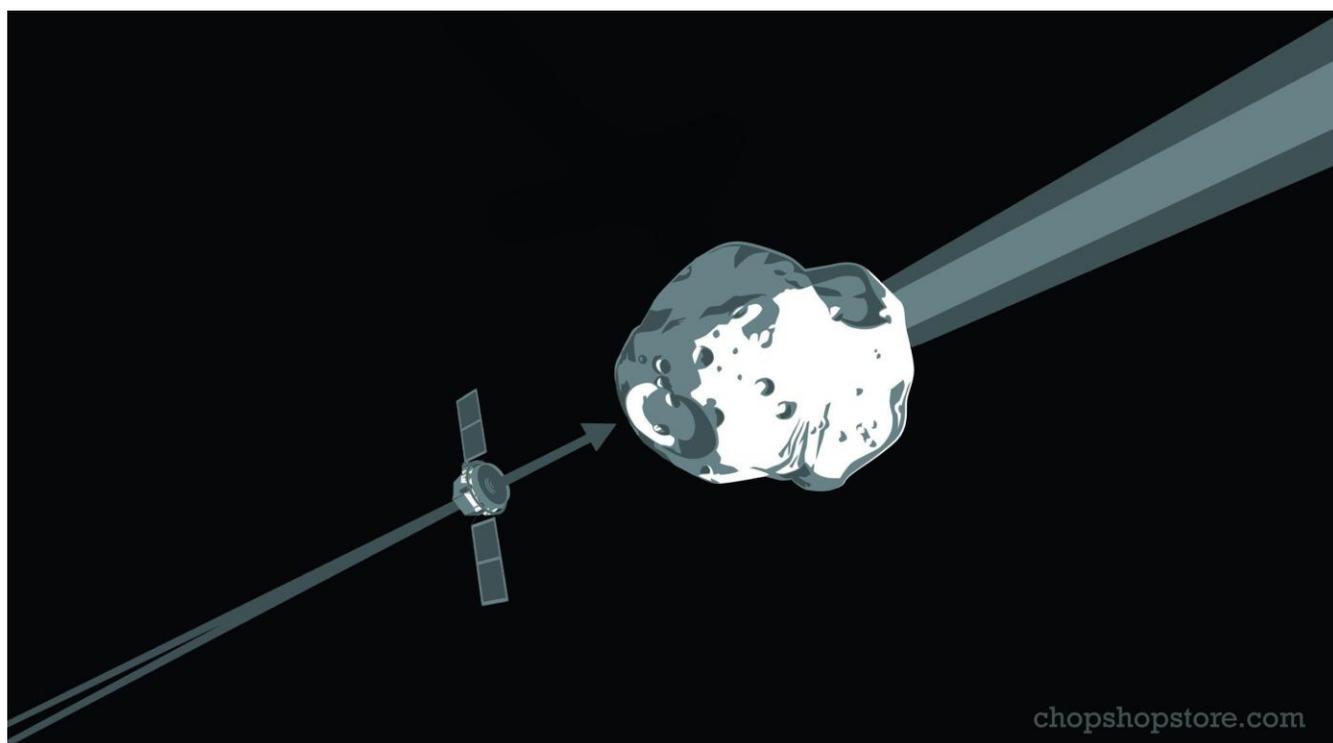


Planetary Defence

Legal Overview and Assessment

**Report by the Space Mission Planning Advisory Group
(SMPAG) Ad-Hoc Working Group on Legal Issues to
SMPAG**



This report was written in 2017 to 2019 by the members of the SMPAG Ad-Hoc Working Group on Legal Issues for the Space Mission Planning Advisory Group (SMPAG). SMPAG is endorsed by the United Nations General Assembly.

NOTE: The views expressed in this Report are the views of the members of the Ad-Hoc Working Group on Legal Issues and do not express the views of national governments, ministries or agencies.

Report coordinators:

- Dr. Line Drube, Institute of Planetary Research, German Aerospace Center (DLR).
- Dr. Alissa J. Haddaji, Planetary Protection and Defense Projects, Committee on Space Research (COSPAR), now Space Law and Policy Faculty, Harvard University.

Contributors, legal experts:

- Teresa Castillo, Director for International Affairs, Mexican Space Agency.
- Prof. Frans G. von der Dunk, College of Law, University of Nebraska-Lincoln.
- Robin J. Frank, Associate General Counsel for International Law, Office of the General Counsel, National Aeronautics and Space Administration (NASA) HQ.
- Dr. Alissa J. Haddaji, Planetary Protection and Defense Projects, Committee on Space Research (COSPAR), now Space Law and Policy Faculty, Harvard University.
- Prof. David A. Koplow, Consultant to NASA Planetary Science Division and the Office of the General Counsel, Professor at Georgetown University Law Center.
- Prof. Irmgard Marboe, Department of European, International and Comparative Law, University of Vienna.
- Prof. Sergio Marchisio, Legal Sciences Department, Sapienza University of Rome, member of the ASI Board of Directors.
- Jean-François Mayence, Legal unit of Belgian Federal Office for Science Policy (BELSPO).
- Nicholas Fernandes, Government Legal Department, UK.
- Prof. Rosa Ma. Ramírez de Arellano, General Deputy Director for International Affairs and Space Security, Mexican Space Agency.
- Alexander Soucek, International Law Division, European Space Agency (ESA).
- Cordula Steinkogler, Department of European, International and Comparative Law, University of Vienna.
- Dr. Peter Stubbe, Department of ESA-Affairs, DLR.

Contributors, technical and scientific experts:

- Dr. Gerhard Drolshagen, SSA Programme Office, ESA.
- Dr. Line Drube, Institute of Planetary Research, DLR.
- Prof. Alan Harris, Institute of Planetary Research, DLR.
- Lindley Johnson, Planetary Science Division, Science Mission Directorate, NASA HQ.
- Daniel Mazanek, NASA Langley Research Center.

Executive Summary

The Ad-Hoc Working Group on Legal Issues provides this report to the Space Mission Planning Advisory Group (SMPAG) with its initial analysis and assessments concerning legal background, issues, and questions related to planetary defence. Much of this report is preliminary and contingent; many points are matters that the legal community has not previously addressed and that remain debatable; and as the relevant facts evolve, additional and revised legal scrutiny may be necessary. Nevertheless, we can offer the following preliminary assessment and we note that unless otherwise specified, the principles set forth below are applicable to whatever planetary defence method is employed in a particular instance:

- If a State has information relevant to the prediction of a Near-Earth Object (NEO) impact threat to Earth, such information should be made available in accordance with elementary considerations of humanity and the Outer Space Treaty, in particular Article XI, which requires State parties to inform others about the results of space activities to the greatest extent feasible and practicable, as well as Article IX, according to which States shall conduct their activities in outer space with due regard to the corresponding interests of all other States Parties.
- If there is a NEO threat, each State has the right and obligation to try to protect its territory and its population, but there is no obligation under international law to assist other States in any particular way or to any particular degree.
- Regarding the choice among planetary defence techniques, the possible placement and use of a Nuclear Explosive Device (NED) in outer space would raise particular issues. International treaties to which most nuclear weapon States are party contain specific prohibitions against particular activities. The Outer Space Treaty prohibits placing a nuclear weapon in orbit, installing it on a celestial body, or stationing it in space in any other manner. We conclude that these prohibitions are applicable even to a NED intended to be used for planetary defence rather than as a weapon. The Limited Test Ban Treaty prohibits any nuclear explosion in outer space, regardless of its intended purpose. Obligations on nuclear non-proliferation restrict the spread of nuclear devices and materials. These restrictions would therefore tightly circumscribe the use of a NED for a planetary defence purpose.
- Any violation of an international obligation in the course of a planetary defence mission, such as the use of NEDs, entails the international responsibility of the States involved and may provide the basis for claims for compensation. There are, however,

circumstances, in particular consent, distress and necessity, which could under certain conditions justify actions that are not in compliance with international law. However, utmost care should be applied when invoking such circumstances.

- The international law applicable to States is also relevant to the space activities of non-State actors such as private corporations. Under the Outer Space Treaty, each party is internationally responsible for the space activities of its governmental agencies and non-governmental entities.
- A State has liability for damage caused by any space object for which it is a launching State. This liability applies for 'fault' for damage inflicted on other space objects in outer space. For damage inflicted on Earth, the liability is 'absolute' (that is, it applies even without any wrongdoing). Absolute liability may include cases where an asteroid is insufficiently deflected and impacts at a different location compared to where it would have struck if there had been no intervention.
- If a State, or an international group such as SMPAG or the International Asteroid Warning Network (IAWN), provides diligent warning and assessment about a NEO threat in good faith that turns out to be erroneous, there is no liability under international law.
- Regarding possible decision-making bodies for planetary defence action planning, the United Nations Security Council (UNSC) has extraordinary power to supersede rules of international law through a decision, which requires the votes of nine out of fifteen Members and no opposing vote by one of the Permanent Five (P5) Members of the UNSC. Other international institutions and organizations could provide valuable political support for a planetary defence action, but do not have the authority to permit actions that are contrary to international law, such as using a NED.

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Introduction

1.1. Introduction

Impacts of near-Earth asteroids and comets have contributed to mass extinctions and the evolution of life on Earth. It is a proven fact that they will continue to hit the Earth at irregular intervals in the future, with the potential for catastrophic damage to life and property. Awareness of the hazard presented by near-Earth objects (NEOs) has grown rapidly during the past few decades as a result of, for example, the impact of Comet Shoemaker-Levy 9 on Jupiter in 1994, observations of fresh craters appearing on the Moon and Mars, and the discovery of more than 22000 NEOs to date, some of which make uncomfortably close approaches to the Earth. Furthermore, most remaining doubt regarding the cause and violence of the Tunguska event of 1908 was swept away after the blast waves were felt from the relatively small (~20 m diameter) object that caused the Chelyabinsk superbolide of 2013 February 15. The blast injured some 1600 people and damaged thousands of buildings, providing a vivid demonstration that impacts of NEOs on the Earth present an on-going significant danger to life and property. While most objects entering the Earth's atmosphere are relatively small and harmless, we should be prepared for threatening approaches of objects with diameters of 50 m or more which impact the Earth on timescales of hundreds of years and could cause major loss of life and infrastructure if a large city were near the impact point.

'Planetary defence' refers to activities and actions to predict and mitigate a potential impact by an asteroid or comet on the Earth. The Space Mission Planning Advisory Group (SMPAG) was established in 2014 after work done by the Working Group on Near-Earth Objects under the mandate of the Scientific and Technical Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) to advise the United Nations in case of an asteroid impact threat. SMPAG recognized the importance of clarifying the legal issues in regard to planetary defence and established the Ad-Hoc Working Group on Legal Issues (SMPAG Legal WG) in February 2016, which started its work in November of the same year. The main purpose of the SMPAG Legal WG is to advise SMPAG with regard to legal aspects of planetary defence against NEO threats. As delineated in the SMPAG Legal WG's terms of reference the scope of the group's work includes describing the existing legal context relevant to the work of SMPAG, identifying, formulating and prioritizing relevant legal questions and issues requiring clarification with regard to planetary defence, and suggesting, where necessary, possible ways forward to deal with legal questions and issues. The SMPAG Legal WG consists of legal experts who work on the legal questions and technical experts who are responsible for clarifying

technical issues and for ensuring that the work of the SMPAG Legal WG is technically sound. The legal experts are nominated by SMPAG Members. They are experts in the fields of international law and space law at universities, international organizations, space agencies or other governmental institutions, and collectively have a breadth of experience in both of these legal areas.

According to its terms of reference, first findings of the SMPAG Legal WG should be presented to SMPAG before the end of 2018. This report represents a first analysis and assessment of the current legal context as well as of relevant legal questions and issues regarding planetary defence. The report is a joint work of all experts involved and is based on the common assessments and analyses of the SMPAG Legal WG.

In the chapter [Obligation to Inform and to Act](#), the rights and obligations of States with regard to certain aspects of planetary defence are analysed from a legal point of view. The chapter [Legality of Planetary Defence Methods](#) deals with legal aspects of the use of the various possible planetary defence methods. In the chapter [Responsibility](#), legal questions relating to the responsibility of States (including how State responsibility differs from liability) and for the involvement of non-governmental entities in planetary defence efforts are analysed. The chapter [Liability](#) addresses the question of liability of States participating in planetary defence efforts, and the chapter [Considerations for Decision Bodies](#) deals with organizational bodies which could possibly be used for international decision making during an actual impact threat. The appendix [Summary of Planetary Defence Methods](#) explains some of the different types of methods considered for planetary defence, and the appendix [Planetary Defence Scenario Case Study 2017](#) is meant as an illustrative example of how an asteroid impact threat scenario and the planetary defence mission options could evolve as well as some of the legal issues encountered.

This report is meant to be a useful, practical guide to the Members of SMPAG rather than as a theoretical academic treatise. Moreover, the report does not deal with questions of cost or other economic considerations, nor does it assess political matters arising with regard to planetary defence. Rather, it aims at presenting a legal analysis of issues related to the work of SMPAG.

This report is based on the existing legal context and the current state of technological development in the field of planetary defence. With the further evolution of the legal as well as the technical context, new legal questions and issues will arise and may need to be addressed, while others might be settled or will appear in a different context.

Furthermore, different NEO threat scenarios will entail different technical possibilities for planetary defence. Important variables in this regard include the size and nature of the NEO, the probability of impact with Earth, and the time available between the discovery of a NEO and a possible impact. This report tries to take account of different possible scenarios and technical options.

In the case of a NEO impact threat emergency situation, there will be limited time to make decisions and take action. It is thus important to examine the possible legal impediments prospectively to ensure that planetary defence measures can be swiftly carried out in accordance with international law.

1.2. General Legal Remarks

Planetary defence activities are, as almost all human activities, subject to legal requirements which have a binding character. The violation of such legal requirements has noticeable consequences, such as the duty of reparation and, depending on the relevant legal system, various enforcement mechanisms and sanctions. They exist on a national and on an international level, sometimes also ‘in between’ on a regional level (such as the laws of the European Union). With respect to planetary defence activities, national and international legal requirements are primarily relevant. International law is mainly addressed to and binding upon States and intergovernmental organizations¹ (which is the reason for its denomination as ‘public international law’). There are also non-binding ‘rules of the road’, such as United Nations General Assembly (UNGA) resolutions and standards. Legal requirements at the national level are addressed to and binding upon governmental and non-governmental entities operating under the jurisdiction of one particular country.

The present report will not deal with national law, which differs from country to country, but will instead analyse existing norms of international law which are relevant for the conduct of planetary defence activities.

There exists a special branch of international law which specifically deals with the conduct of States and intergovernmental organizations (such as the European Space Agency) in the

¹ Space law also has implications for non-governmental actors, for example Article VI of the Outer Space Treaty. See discussion in [4.4. The role of non-governmental entities and corresponding legal considerations](#) below.

exploration and use of outer space, namely international space law. As planetary defence activities will be activities carried out in outer space, international space law is applicable.

International space law most importantly consists of a set of multilateral treaties which were adopted between 1967 and 1979 in the framework of COPUOS: the Outer Space Treaty,² the Rescue Agreement,³ the Liability Convention,⁴ the Registration Convention,⁵ and the Moon Agreement.⁶ They set forth the basic principles that govern human activities in outer space. The first four treaties are widely accepted and have been ratified by a large number of countries, including the important space faring nations, while the last one has only a few State Parties. Furthermore, treaties and regulations of the International Telecommunication Union (ITU) are also applicable to space activities.

The UN space treaties are supplemented by UN General Assembly resolutions, which were also developed under the auspices of COPUOS and further address concepts included in the treaties. In addition, a number of non-binding instruments, which were developed at the international and regional levels and contain technical, safety and environmental standards, are relevant in the conduct of space activities.

Article III of the Outer Space Treaty provides that space activities must be carried out in accordance with international law. Therefore, the analyses and discussions in this report also take account of public international law, such as treaties relevant to the use of Nuclear Explosive Devices (NEDs) in outer space. An important feature of public international law is that States are at the same time the creators and the main addressees. According to the Statute of the

² Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, opened for signature 27 January 1967, entered into force 10 October 1967, 610 UNTS 205, hereafter Outer Space Treaty.

³ Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, opened for signature 22 April 1968, entered into force 3 December 1968, 672 UNTS 119, hereafter Rescue and Return Agreement.

⁴ Convention on International Liability for Damage Caused by Space Objects, opened for signature 29 March 1972, entered into force 1 September 1972, 961 UNTS 187, hereafter Liability Convention.

⁵ Convention on Registration of Objects Launched into Outer Space, opened for signature 14 January 1975, entered into force 15 September 1976, 1023 UNTS 15, hereafter Registration Convention.

⁶ Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, opened for signature 18 December 1979, entered into force 11 July 1984, 1363 UNTS 3, hereafter Moon Agreement.

International Court of Justice (ICJ),⁷ the main sources of public international law include treaties, customary international law,⁸ and general principles of law.⁹

A 'treaty', according to the Vienna Convention on the Law of Treaties, is "*an international agreement concluded between States in written form and governed by international law, whether embodied in a single instrument or in two or more related instruments and whatever its particular designation.*"¹⁰ A 'treaty' may also be designated, for instance, as convention, charter, covenant, pact, agreement, etc.¹¹ A treaty is generally binding only on states that are parties to it. The ratification of a treaty establishes the consent of a State to be bound by it.¹² The signature of a treaty generally does not immediately render the treaty binding upon the State, but only obliges it to refrain from acts that would defeat the object and purpose of the treaty.¹³

In addition to treaties, non-binding international instruments, such as United Nations General Assembly resolutions, guidelines, and standards, are relevant. Such instruments are not legally binding but constitute voluntary (political) commitments to abide by them.¹⁴ They can provide practical guidance for actors and may indicate the lawfulness of a behaviour, which is in accordance with them. They may also evolve into customary international law, which is the second main source of international law. Non-binding international instruments can also serve as a basis for the elaboration of national rules as well as of binding international instruments. Moreover, they can constitute a basis for the interpretation and application of existing international law.

⁷ Art. 38, Statute of the International Court of Justice, opened for signature 26 June 1945, entered into force 24 October 1945, USTS 993.

⁸ Customary international law is constant and uniform state practice in combination with '*opinio iuris*' (opinion of States about the legally binding nature of the respective rule).

⁹ General principles of law are principles common to the most important legal systems in the world.

¹⁰ Art. 2, Vienna Convention on the Law of Treaties (VCLT), opened for signature 23 May 1969, entered into force 27 January 1980, 1155 UNTS 331.

¹¹ For the United States, treaties are denominated as 'treaties' or as 'executive agreements,' which do not need Senate approval.

¹² Art. 14, VCLT. In addition, the consent of a State to be bound by a treaty can also be expressed by acceptance or approval.

¹³ *Ibid.*, Art. 18. (Note: *Ibid./Ibidem*, means at the same place (used to save space in textual references to a quoted work which has been mentioned in a previous reference)).

¹⁴ For a detailed discussion of the effects of non-binding instruments see A. Boyle, "Soft Law in International Law-Making", M. D. Evans, *International Law*, 4th ed., Oxford University Press, 2014, pp. 118-136. More specifically on soft law in space activities see: M. Ferrazzani, "Soft Law in Space Activities – An Updated View" in I. Marboe (ed.), *Soft Law in Outer Space*, Böhlau, 2012, pp. 99-117.

1.3. Acronyms and Abbreviations

- **ARSIWA:** International Law Commission Articles on the Responsibility of States for Internationally Wrongful Acts
- **COPUOS:** United Nations Committee on the Peaceful Uses of Outer Space
- **IADC:** Inter-Agency Space Debris Coordination Committee
- **IAWN:** International Asteroid Warning Network
- **ICJ:** International Court of Justice
- **ILC:** International Law Commission (United Nations General Assembly sub-organ for the codification and progressive development of international law)
- **ISO:** International Organization for Standardization
- **Liability Convention:** Convention on International Liability for Damage Caused by Space Objects
- **Limited Test Ban Treaty:** Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water
- **Moon Agreement:** Agreement Governing the Activities of States on the Moon and Other Celestial Bodies
- **NED:** Nuclear Explosive Device
- **NEO:** Near-Earth Object
- **Nuclear Non-Proliferation Treaty:** Treaty on the Non-proliferation of Nuclear Weapons
- **Outer Space Treaty:** Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies
- **R2P:** Responsibility to Protect
- **SMPAG:** Space Mission Planning Advisory Group
- **SMPAG Legal WG:** SMPAG Ad-Hoc Working Group on Legal Issues
- **UNGA:** United Nations General Assembly
- **UNSC:** United Nations Security Council
- **UNTS:** United Nations Treaty Series
- **USTS:** United States Treaty Series
- **VCLT:** Vienna Convention on the Law of Treaties

1.4. Vocabulary List

In this report, the terms below are defined as follows:

Technical expressions:

- **Mitigation:** in the context of planetary defence, measures designed to detect and monitor asteroids and comets that may impact the Earth and predict, prevent, prepare for reducing and/or responding to the damage that may be caused by such a collision.
- **Near-Earth Object (NEO):** an asteroid or a periodic comet having an orbit that brings it within 1.3 astronomical units¹⁵ of the Sun.¹⁶ *“An asteroid is an irregularly shaped rocky body orbiting the Sun that does not qualify as a planet or a dwarf planet under the International Astronomical Union’s (IAU) definitions of those terms introduced in 2006. ... In contrast to comets, asteroids are inert bodies that do not display a coma of gas and dust (although a few objects originally classed as asteroids have subsequently been found to display cometary activity)”*.¹⁷
- **Natural threat:** a non-man-made incident caused by biological, geological, seismic, hydrological, or meteorological conditions or processes in the natural environment. The threat posed by natural events is dependent on the location, community infrastructure, and climate.¹⁸
- **Planetary defence:** refers to activities and actions to predict and mitigate a potential impact by an asteroid or comet on the Earth.¹⁹
- **Space debris:** are all man-made objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional.²⁰

Legal expressions:

- **Damage:** loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organizations.²¹

¹⁵ 1 astronomical unit is approximately 150 million kilometers.

¹⁶ Report of the Near-Earth Object Science Definition Team, Update to Determine the Feasibility of Enhancing the Search and Characterization of NEOs, September 2017, NASA.

¹⁷ Harris, A. W. in Muriel Gargaud (ed.), Encyclopedia of Astrobiology, Springer-Verlag Berlin Heidelberg 2011

¹⁸ Ibid.

¹⁹ SMPAG Terms of Reference (<https://www.cosmos.esa.int/web/smpag/terms-of-reference-v0>)

²⁰ 3.1 IADC Space Debris Mitigation Guidelines.

²¹ Art. I (a), Liability Convention.

- **International Law (also Public International Law):** can be described as law which regulates the relations between subjects of international law, primarily States and international organisations. The main sources of public international law are treaties, customary international law,²² and general principles of law (*i.e.*, principles common to the most important legal systems in the world).²³ An important feature of public international law is that States are at the same time the creators and the main addressees of rules of international law.
- **International Space Law:** can be regarded as a subset of rights and obligations of States within the area of international law specifically focused on the regulation of space activities. The core of international space law consists of a set of multilateral treaties which were adopted between 1967 and 1979 in the framework of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS). They contain the fundamental principles that govern human activities in outer space. The treaties have been supplemented by non-legally binding UN General Assembly resolutions, which were also developed by COPUOS and further address areas included in the treaties. In addition, treaties and regulations of the International Telecommunication Union (ITU), as well as a number of non-binding instruments containing in particular technical and/or safety standards are relevant for the conduct of space activities.
- **Law:** a rule or set of rules binding upon the addressee. Its violation usually leads to specific legal consequences, such as the duty of reparation or specific sanctions enforced by authorities.
- **Mandate:** enables and delimits a specified scope of action.
- **Space object:** according to the Liability Convention and the Registration Convention the term space object includes component parts of a space object as well as its launch vehicle and parts thereof.²⁴ In legal literature, there is a general understanding that the term relates to artificial, (*i.e.* human-made) objects. Typically, spacecraft used for the purpose of planetary defence would therefore qualify as space objects. An asteroid, however, would not qualify as a space object in the meaning of international space law.
- **Ratification and signature of a treaty:** ratification is the act of a State to express its willingness to accept a treaty as binding.²⁵ By contrast, signature generally does not

²² Customary international law is consistent and uniform State practice in combination with '*opinio iuris*' (opinion of States about the legally binding nature of the respective rule).

²³ Art. 38, Statute of the International Court of Justice.

²⁴ Art. I (d), Liability Convention; Art. I (b), Registration Convention.

²⁵ Art. 14, VCLT.

establish the consent of a State to be bound by a treaty but only signifies the end of the negotiations and the acceptance of the text. Signatures generally only create the obligation of a State to refrain from acts that would defeat the object and purpose of the treaty.²⁶

- **Treaty (may also be designated as a convention, agreement, charter, covenant, pact, etc.):** a treaty is *“an international agreement concluded between States in written form and governed by international law, whether embodied in a single instrument or in two or more related instruments and whatever its particular designation.”*²⁷
- **Binding Agreement vs. Non-binding Agreement:** under international law, the violation of a binding agreement entails State responsibility, most importantly the obligation to reparation. The violation of a non-binding agreement does not have this immediate effect but may have other, mainly political, consequences.

²⁶ Ibid., Art. 18.

²⁷ Ibid., Art. 2.

2. Obligation to Inform and to Act

2.1. Introduction

In order to assess the existence of rights and obligations of States related to planetary defence, the SMPAG Legal WG reviewed several instruments and documents. The rights or obligations of States are here considered with respect to principles of international law, such as the principles of sovereignty, non-interference in another State's internal affairs, responsibility, liability, and respect for human rights. Given the broad range of possible scenarios that may arise from a NEO impact threat, a State's obligation to inform and to act will depend on the specific circumstances of the situation. The particular balance of interests at stake between States and their nationals in the context of a specific scenario will be a critical aspect in assessing the relevant international legal elements to be considered together with the principles referenced above.

The reviewed instruments and documents do not specifically concern the situation of a NEO impact threat. The lack of legal precedent should be kept in mind in the legal analysis and in the consideration of solutions from existing instruments of international law and public policy.

2.2. Are States obligated to inform others about a potential NEO impact threat?

The question addressed in this section is whether international law imposes any obligation on States to inform other States about a potential NEO impact threat. Whether there is an ethical or public service responsibility to do so is beyond the scope of this report.

Outer Space Treaty

The Outer Space Treaty provides the basic framework on international space law and includes the main principles that govern the use of outer space including the Moon and other celestial bodies.

Space missions fall under the scope of that treaty. Three provisions may be highlighted therefrom:

- **Article I:** *"The exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree*

of economic or scientific development, and shall be the province of all mankind."

- **Article IX:** *"In the exploration and use of outer space, including the Moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of cooperation and mutual assistance and shall conduct all their activities in outer space, including the Moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty."*
- **Article XI:** *"In order to promote international cooperation in the peaceful exploration and use of outer space, States Parties to the Treaty conducting activities in outer space, including the Moon and other celestial bodies, agree to inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of the nature, conduct, locations and results of such activities. On receiving the said information, the Secretary-General of the United Nations should be prepared to disseminate it immediately and effectively."*

Article XI may provide a legal basis for an obligation to share the scientific results of a space activity when those results demonstrate that an asteroid or comet could collide with the Earth *"to the greatest extent feasible and practicable."*

Moon Agreement

The Moon Agreement features provisions in relation with hazards detected in outer space. However, the legal relevance of those provisions with respect to the scope of this report is limited by the fact that few space-faring nations are parties and thus are bound by it.²⁸

UN General Assembly Resolution on Remote Sensing

In addition to the treaties discussed above, the United Nations General Assembly has adopted several resolutions in various domains of outer space activities. One of these resolutions is of particular relevance with regard to the duty to inform about a potential NEO impact threat. The

²⁸ Only 18 States Parties in January 2018. That being said, the treaty has been adopted by a United Nations General Assembly resolution as a further development of the principles of the 1967 Outer Space Treaty specifically to celestial bodies. Art. 5.3 provides *"In carrying out activities under this Agreement, States Parties shall promptly inform the Secretary-General, as well as the public and the international scientific community, of any phenomena they discover in outer space, including the Moon, which could endanger human life or health, as well as of any indication of organic life."*

resolution on remote sensing includes some wording that may be considered for the deduction of a 'duty to inform':

Principle X: "(...) (S)tates participating in remote sensing activities that have identified information in their possession that is capable of averting any phenomenon harmful to the Earth's natural environment shall disclose such information to States concerned."

Although this principle relates to certain Earth observation activity (by opposition to outer space observation), the idea of sharing results of a space mission to mitigate possible damage is reiterated in this non-binding instrument.²⁹

Elementary considerations of humanity

The case law of the International Court of Justice (ICJ) adds another element to the discussion on the duty of States to inform, namely 'elementary consideration of humanity'. In the Corfu Channel case, the ICJ found that Albania was under the obligation to inform foreign vessels about the existence of a minefield in its territorial waters. This obligation was, according to the Court, based on "*general and well-recognized principles, namely: elementary considerations of humanity*".³⁰ In this case, the failure to notify foreign ships led to the death or injury of over 80 persons. Since "*nothing was attempted by the Albanian authorities to prevent the disaster*", the Court found that Albania was responsible under international law for the damage and loss of human life which resulted from the explosion of the minefield and that there was a duty upon Albania to pay compensation.³¹ While the case does not address the specific situation of a NEO impact threat, it can nevertheless support the argument that elementary considerations of humanity can form the basis of a duty to share information in order to avoid the loss of human lives.

Other international law principles

The principle of non-intervention into the internal affairs of other States could also be of relevance in situations where false information is provided or relevant information is not shared with the intention of negatively affecting another State, ranging from economic downturn, to the devastation of the territory and the loss of human lives. The principle of non-intervention in

²⁹ The Rio Declaration on Environment and Development also refers to natural disasters, although not as a consequence of an event that could/should be mitigated, but rather as the cause of an impact on the environment. Principle 18 states "*States shall immediately notify other States of any natural disasters or other emergencies that are likely to produce sudden harmful effects on the environment of those States. Every effort shall be made by the international community to help States so afflicted.*"

³⁰ Corfu Channel case, Judgment of April 9th, 1949: ICJ Reports 1949, p. 4, p. 22.

³¹ Ibid., p. 23.

matters within the domestic jurisdiction of a State forms part of customary international law and is founded on the concept of the territorial sovereignty of States. It includes the prohibition of the interference into the political, economic, social and cultural affairs of another State.³²

2.3. Do States have an obligation to act (participate in planetary defence efforts)?

Among the existing multilateral instruments of international law, the SMPAG Legal WG pointed out the following instruments for consideration with regard to the question whether States have an obligation to take action to mitigate a NEO impact threat.

United Nations Charter

This universal treaty³³ provides for a number of critical international law principles, some of them of *jus cogens*.³⁴ It serves as an essential 'Constitution' for international law. In this treaty, the following articles seem particularly relevant in order to provide a legal basis for States' rights and obligations/responsibilities to participate in planetary defence:

- **Article 1:** "*The purposes of the United Nations are: (...) To achieve international co-operation in solving international problems of an economic, social, cultural, or humanitarian character, and in promoting and encouraging respect for human rights and for fundamental freedoms for all without distinction as to race, sex, language, or religion (...)*";
- **Article 2:** "*All Members shall give the United Nations every assistance in any action it takes in accordance with the present Charter*";
- **Article 55:** "*With a view to the creation of conditions of stability and well-being (...) the United Nations shall promote (...) solutions of international economic, social, health, and related problems*" and **Article 56:** "*All Members pledge themselves to take joint and separate action in co-operation with the Organization for the achievement of the purposes set forth in Article 55*";

³² Shaw, M., "International Law", Cambridge University Press, 8th ed., 2017, p. 874; Military and Paramilitary Activities in and against Nicaragua (Nicaragua v. United States of America), Merits, Judgment, ICJ Reports 1986, p. 14, p. 93-94, 97-98, 106; Corfu Channel case, Judgment of April 9th, 1949: ICJ Reports 1949, p. 4, p. 35.

³³ 193 Member States.

³⁴ *Jus cogens* is a set of peremptory norms of general international law, which are accepted and recognized by the international community of States as a whole as norms from which no derogation is permitted and each of which can be modified only by a subsequent norm of general international law having the same character. (1969 Vienna Convention, Art. 53). They can be assimilated as a form of international constitutional law.

- **Article 99:** "*The Secretary-General may bring to the attention of the Security Council any matter which in his opinion may threaten the maintenance of international peace and security.*"

These provisions establish certain aspects of the mission of the United Nations (UN), which includes solving problems of humanitarian nature. A specific role is assigned to States, as Members of the UN, to provide *every assistance* to fulfil that mission, as well as to the Secretary-General to highlight any threat to international security.

Those provisions must be complemented with the non-binding *Declaration on Principles of International Law concerning Friendly Relations and Co-operation among States in accordance with the Charter of United Nations* (UN General Assembly Resolution 2625, 1970), which contains some fundamental principles governing the relations between States, e.g. the prohibition of the use of force by States, the peaceful settlement of disputes, the non-intervention in another State's domestic matters, and cooperation in the economic, social and cultural fields as well as in the field of science and technology, and in the promotion of universal respect for, and observance of, human rights and fundamental freedoms.

Other International Instruments and Principles

Other international instruments and principles could be regarded as complementing the legal basis for a State's action against NEO threats, including several international human rights conventions.³⁵

The idea, for instance, that either States or citizens may assert their right to safety and security has been discussed in the context of the implementation of several of these conventions, from which individual rights may be directly claimed.³⁶ Although some of these conventions³⁷

³⁵ These include for instance:

- a) International Covenant on Civil and Political Rights, opened for signature 16 December 1966 entered into force 23 March 1976, 999 UNTS 171.
- b) International Covenant on Economic, Social and Cultural Rights, opened for signature 19 December 1966, entered into force, 3 January 1976 993 UNTS 3.
- c) European Convention for the Protection of Human Rights and Fundamental Freedoms, opened for signature 4 November 1950, entered into force 3 September 1953, 213 UNTS 22.
- d) American Convention on Human Rights, opened for signature 22 November 1969, entered into force 18 July 1978, 1144 UNTS 123.
- e) African Charter on Human and Peoples' Rights (Banjul Charter) opened for signature 27 June 1981, entered into force 21 October 1986, 1520 UNTS 217.

³⁶ See Lazarus, L., *The Right to Security - Securing Rights or Securitising Rights*, in *Examining Critical Perspectives on Human Rights* (Dickson et al. editors, Cambridge CUP, 2012).

³⁷ Art. 5 of the European Convention for the Protection of Human Rights and Fundamental Freedoms and Art. 9 of the International Covenant on Civil and Political Rights.

actually state the right of people to ‘*security of [their] person*’, this concept must be understood in close connection with the one of ‘*liberty*’.³⁸

Moreover, the human right to life³⁹ could present a basis for a duty to act in case of a NEO threat scenario. While it creates primarily a ‘negative’ obligation of States not to interfere, it also contains a ‘positive’ obligation of States to ensure the right to life of those under their jurisdiction, which includes the duty to take appropriate steps to safeguard human lives.⁴⁰ With respect to disasters more specifically, the International Law Commission (ILC) in its *Articles on the protection of persons in the event of disasters* highlights that the protection of the right to life “*entails a positive obligation on States to take the necessary and appropriate measures to prevent harm from impending disasters*”.⁴¹ An important legal foundation for this obligation is also the widespread practice of States reflecting their commitment to reduce the risk of disasters.⁴²

³⁸ Governments generally consider the concept of security as resulting from a balance of interests, rights and freedoms among human societies or groups. Another consideration is the fact that lawmakers sometimes struggle with concepts incorporating basic values. For instance, para. 143 of the United Nations General Assembly 2005 World Summit Outcome Document in which States ‘*recognize that all individuals, in particular vulnerable people, are entitled to freedom from fear and freedom from want, with an equal opportunity to enjoy all their rights and fully develop their human potentials*’ and, to that end ‘*commit [themselves] to discussing and defining the notion of human security in the General Assembly*’. It remains to be seen whether further developments of the notion of ‘security’ will encompass the guaranteed response to natural threats, such as NEO’s impact, but in the meantime concepts such as ‘*freedom from fear*’ or ‘*freedom from want*’ are unlikely to provide a solid argument in favour of compelling States to act.

³⁹ Article 6 of the International Covenant on Civil and Political Rights; Article 2 of the European Convention for the Protection of Human Rights and Fundamental Freedoms; Article 4 of the American Convention on Human Rights; Article 4 of the African Charter on Human and Peoples' Rights.

⁴⁰ N. Petersen, “Life, Right to, International Protection”, *Max Planck Encyclopedia of Public International Law*, October 2012; P. Alston and R. Goodman, *International Human Rights*, Oxford University Press, 2013, pp. 181-185; R. White and C. Ovey, *Jacobs, White, and Ovey: The European Convention on Human Rights*, Oxford University Press, 5th ed., 2010, pp. 152-156.

⁴¹ ILC, Draft articles on the protection of persons in the event of disasters, with commentaries, Report of the International Law Commission on the work of its sixty-eighth session, A/71/10, 2016, Art. 9, Commentary (4). This is confirmed by the decisions of international tribunals, notably the European Court of Human Rights judgments in the *Öneryıldız v. Turkey* (European Court of Human Rights, *Oneryildiz v. Turkey* [GC], no. 48939/99, judgment of 30 November 2004) and *Budayeva and Others v. Russia* (European Court of Human Rights, *Budayeva and Others v. Russia*, nos. 15339/02, 21166/02, 20058/02, 11673/02 and 15343/02, judgment of 20 March 2008) cases, which affirmed the duty to take preventive measures. However, this obligation is to be assessed in consideration of the broader context of the existing capacity and availability of resources of the State in question. See ILC Draft articles on the protection of persons in the event of disasters, with commentaries, Art. 9, Commentary (11).

⁴² States and international organizations have adopted multilateral, regional and national instruments concerned with reducing the risk of disasters, including action plans for the implementation of the Sendai Framework for Disaster Risk Reduction. In the case of a NEO impact threat, the obligation to protect the right to life of those under their jurisdiction could thus require States to carry out a planetary defence mission in order to save human lives, subject to the availability of national resources and capabilities.

The *International Covenant on Economic, Social and Cultural Rights* can be distinguished for some additional elements it brings in the definition of general human welfare standards that States are committed to maintain. It contains for instance a duty of States to achieve the full realisation of the right to “*enjoyment of the highest attainable standard of physical and mental health*”.⁴³

The SMPAG Legal WG also reviewed documentation and doctrine discussing the existence of a State responsibility to protect citizens against natural disasters. Among the relevant documentation, the Report of the International Commission on Intervention and State Sovereignty delivers a thorough analysis of the responsibility to protect in the case of natural catastrophes.⁴⁴

Other principles and concepts of international law that are of importance in the context of the conduct of planetary defence missions are the territorial sovereignty of States and the duty of non-intervention. Territorial sovereignty is an essential foundation of a stable system of international relations between independent, equal States. Principal corollaries of the sovereignty and equality of States under international law are the jurisdiction of States over their territory and the population living there as well as the duty of non-intervention in internal affairs of other States.⁴⁵ This has several consequences in case of a NEO impact threat scenario. Firstly, the State(s) potentially affected by a NEO impact have the primary role in protecting the population from harm which could be caused by the NEO impact on the territory under their jurisdiction. Secondly, in the absence of specific and clear obligations under international law, States are free to decide whether they provide assistance to other States that are threatened by a possible NEO impact. And thirdly, any planetary defence action that affects the territory and population under the jurisdiction of another State would be contrary to international law, unless the action is justified by a circumstance precluding wrongfulness or authorized by a decision of the UN Security Council (see Chapters on Responsibility and Decision Bodies). Thus, the conduct of a mission that would affect another State, for instance the diversion of an asteroid so that it impacts a State that it would not have impacted, if the mission had not been undertaken,

⁴³ To this end, the States Parties should take appropriate actions towards (notably) ‘*the improvement of all aspects of environmental and industrial hygiene*’ (Art. 12). Whether the prevention of a NEO impact would fall under this duty could be further investigated but would be beyond the scope of this report.

⁴⁴ International Commission on Intervention and State Sovereignty, *The Responsibility to Protect*, December 2001.

⁴⁵ Shaw, M., “*International Law*”, Cambridge University Press, 8th ed., 2017, pp. 166-169, 874; Brownlie, I., “*Principles of Public International Law*”, Oxford University Press, 7th ed., 2008, pp. 289-290. The term “*jurisdiction*” describes “*the power of the state under international law to regulate or otherwise impact upon people, property and circumstances*”. Shaw, M., “*International Law*”, Cambridge University Press, 8th ed., 2017, p. 483.

would infringe the territorial sovereignty of that State and would therefore be prohibited under international law according to the principle of non-intervention. In certain cases, such an intervention could also violate the prohibition of the use of force in international law.

2.4. Conclusion

The SMPAG Legal WG addressed the question of a possible obligation for States under international law to respond in order to mitigate disasters related to a NEO impact with Earth and to inform about a potential NEO impact threat.

The assessment of existing instruments led to the following findings:

There is no binding or non-binding instrument of international law that specifically and explicitly addresses planetary defence. Existing legal instruments may nevertheless, under certain conditions, provide a legal basis for a duty of States to take appropriate actions towards the mitigation of a NEO impact threat, taking notably into account their resources, level of scientific or technological capacity in this area and relevant cooperation with other States or international organizations.

Currently, some States do voluntarily undertake planetary defence activities in order to predict and mitigate a potential impact by an asteroid or comet on the Earth, and some do not, depending on their respective capabilities and resources.

The list of instruments in this chapter is not meant to be exhaustive, but includes the main provisions in current international law from which can be drawn elements to establish the legal basis for a duty of States to take appropriate actions for planetary defence purposes.

If a State has information relevant to the prediction of a NEO impact threat to Earth, such information should be made available in accordance with elementary considerations of humanity and with the Outer Space Treaty, in particular Article XI, which requires State parties to inform others about the results of space activities to the greatest extent feasible and practicable, as well as Article IX, according to which States shall conduct their activities in outer space with due regard to the corresponding interests of all other States Parties.

If there is a NEO impact threat, each State has, in particular under international human rights considerations, the right and obligation to try to protect its territory and its population, but there

is no clear obligation under international law to assist other States in any particular way or to any particular degree.

Given the absence of international instruments that explicitly address planetary defence and the short time that might be available to take decisions and actions at the international level in case of a real NEO impact threat situation, it might be prudent to seek solutions for addressing such a situation already before an impact threat is discovered. Therefore, a template could be drafted in advance so that it is available in case a NEO threat situation occurs and can be adapted to the specific situation and adopted by the international community in a rather short time. This could include modalities for the organization of cooperation among States and intergovernmental organizations as well as the setting-up of common procedures to take planetary defence action. In addition, modalities with regard to the dissemination of information regarding NEO impact threats could also form part of such a template. IAWN and SMPAG are developing criteria for impact response action which could be included in the template and could then be applied by the international community in case an actual NEO impact threat occurs.

3. Legality of Planetary Defence Methods

3.1. Introduction

This chapter gives an overview of existing rules of international law regarding the legality of the use of planetary defence methods. It concentrates on those methods that have reached a sufficient level of technical maturity, most importantly the slow push/pull methods and the impulsive methods, as summarized in Appendix 10.[1. Summary of planetary defence methods for asteroids and comets.](#)

As noted above, the use of planetary defence methods needs to be evaluated from the perspective of general public international law and international space law. Instruments relevant to planetary defence missions include the UN Charter, the Outer Space Treaty, in particular provisions regarding the placement of certain types of weapons in outer space and environmental considerations, as well as international treaties prohibiting nuclear explosions in outer space and the proliferation of nuclear explosive devices.

3.2. Slow push/pull methods and impulsive methods

The slow push/pull methods, which include gravity tractors, enhanced gravity tractors, ion beam shepherds and laser ablation, do not as such raise any specific issues of legality under international law. However, in case of malfunctions, failures and damage caused on Earth or in outer space, the general rules on responsibility and liability as discussed later in the [Responsibility](#) chapter and the [Liability](#) chapter apply.

Impulsive methods, such as kinetic impactors, conventional explosives, and in particular nuclear explosive devices, may involve some specific questions regarding the legality of their use, in addition to the general rules on responsibility and liability in case of malfunctions, failures or damage (as discussed in the [Responsibility](#) and [Liability](#) chapters). Relevant legal rules are contained in the Charter of the United Nations, Article IV Outer Space Treaty, as well as treaties regulating nuclear explosions in outer space and the transfer, acquisition and use of NEDs.

3.2.1. United Nations Charter

One of the central provisions of the United Nations Charter, which could be of relevance in the context of planetary defence, is the prohibition of the use of force. Article 2(4) of the UN Charter stipulates that *“all Members shall refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any State, or in any other manner inconsistent with the Purposes of the United Nations”*.⁴⁶ Since planetary defence devices are not developed for use against the territorial integrity or political independence of States, it can be concluded that the normal use of planetary defence methods is not prohibited by Article 2(4) of the UN Charter.

3.2.2. Article IV Outer Space Treaty

Article IV of the Outer Space Treaty prohibits the conduct of military manoeuvres, the establishment of military installations and the testing of any kind of weapons on the Moon and on celestial bodies and limits their use exclusively to peaceful purposes.⁴⁷ This means that celestial bodies are generally demilitarized and must not be used for military purposes.⁴⁸ Only the use of military personnel for scientific research or other peaceful purposes and the use of any equipment or facility necessary for the peaceful exploration of celestial bodies are not prohibited.⁴⁹ The question therefore arises whether the devices used for the impulsive methods could be qualified as ‘weapons’ from a legal point of view.

3.2.3. Can planetary defence devices be qualified as ‘weapons’?

Generally, the term ‘weapon’ can be defined as *“any object used in fighting or war, such as a gun, bomb, knife”*⁵⁰ or as *“an instrument of any kind used in warfare or in combat to attack and overcome an*

⁴⁶ The term ‘force’ as used in Article 2(4) is generally recognized as referring to ‘armed force’. See e.g. O. Dörr and A. Randelzhofer, “Article 2 (4)” in B. Simma et al. (eds.), *The Charter of the United Nations: A Commentary*, 2012, p. 208; J. Crawford, “Brownlie’s Principles of Public International Law”, 2012, pp. 744-745.

⁴⁷ Art. IV, para. 2, sentences 1 and 2 Outer Space Treaty. Art. 3 Moon Agreement reiterates that *“the Moon shall be used by all States Parties exclusively for peaceful purposes”* and that the establishment of military installations, the testing of any type of weapons and the conduct of military manoeuvres on the Moon is prohibited. Note that the provisions of the Moon Agreement apply not only to the Moon but also other celestial bodies within the solar system, other than the Earth (Art. 1, para. 1 Moon Agreement).

⁴⁸ E.g. B. Cheng, “Studies in international space law”, 1997, pp. 516-519; K.-U. Schrogl and J. Neumann, “Article IV” in S. Hobe et al. (eds.), *Cologne Commentary on Space Law*, Vol. I, 2009, pp. 75-85; F. Tronchetti, “Legal Aspects of the Military Uses of Outer Space”, in F. von der Dunk with F. Tronchetti (eds.), *Handbook of Space Law*, 2015, pp. 335-341.

⁴⁹ Art. IV, para. 2, sentences 3 and 4 Outer Space Treaty.

⁵⁰ Cambridge English Dictionary.

enemy".⁵¹ 'Nuclear weapons' have been defined by the International Court of Justice (ICJ) as "*explosive devices whose energy results from the fusion or fission of the atom*".⁵² With regard to the term 'weapons of mass destruction', the United Nations Commission for Conventional Armaments determined that 'weapons of mass destruction' should be defined "*to include atomic explosive weapons, radio-active material weapons, lethal chemical and biological weapons, and any weapons developed in the future which have characteristics comparable in destructive effect to those of the atomic bomb or other weapons mentioned above*".⁵³ In modern international law and international relations, the term 'weapons of mass destruction' has "*simply become shorthand for nuclear, chemical, and biological weapons. The common denominator of weapons classified as such is that the consequences of their use cannot be determined and controlled, and the damage they cause is indiscriminate*".⁵⁴ This is also in line with the ordinary meaning of 'weapon of mass destruction' as a "*weapon intended to cause widespread devastation and loss of life, esp. a chemical, biological, or nuclear weapon*".⁵⁵

Generally, planetary defence devices are not developed for use in warfare to attack or overcome an enemy. They are also not intended to cause widespread devastation and loss of life. On the contrary, planetary defence methods are intended to be specifically targeted at a potentially hazardous asteroid or comet in order to save lives and prevent widespread devastation on Earth. However, not only the purpose for which something is used determines its qualification as a weapon. Any possible dual-use applications would not change the inherent nature of 'weapons', 'nuclear weapons' or 'weapons of mass destruction', which result from their initial designation. A 'weapon' remains a 'weapon' irrespective of whether it may be used for non-destructive civilian purposes.

The problem arising in this context is that it is difficult to construct a device that could be used only against a NEO and not have some applicability against other targets. A planetary defence device could also be used as a weapon. This could also raise political concerns at the international level. While political assessments lie beyond the scope of this report, it should be noted that broad international cooperation and information sharing with regard to the planning

⁵¹ Oxford English Dictionary.

⁵² Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, ICJ Reports 1996, p. 226, para. 35.

⁵³ Commission for Conventional Armaments, "Resolutions Adopted by the Commission at its Thirteenth Meeting, 12 August 1948, and a Second Progress Report of the Commission", 18 August 1948, S/C.3/32/Rev.1, p. 2.

⁵⁴ H. A. Strydom, 'weapons of mass destruction', Max Planck Encyclopedia of Public International Law, 2017.

⁵⁵ Oxford English Dictionary.

and conduct of planetary defence missions could enhance transparency and confidence among States and avoid mistrust and misperceptions at the international level.

3.2.4. Nuclear explosive devices (NEDs)

3.2.4.1. *Article IV Outer Space Treaty*

With particular relevance regarding the use of NEDs for planetary defence purposes, Article IV, paragraph 1 of the Outer Space Treaty determines that States Parties “*undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner*”. Since, following the analysis above, NEDs can be qualified as ‘nuclear weapons’, their use in the context of planetary defence missions falls under the scope of this provision.

3.2.4.2. *Treaties regulating nuclear explosions in outer space and the transfer, acquisition and use of nuclear explosive devices*

Several international treaties are of relevance in the context of the use of NEDs for planetary defence as they are intended to arrest the arms race among countries that possess nuclear weapons, prohibit the proliferation of nuclear explosive devices and forbid nuclear explosions in outer space.

Article I of the **Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water**, which entered into force in 1963, provides that States Parties undertake “*to prohibit, to prevent, and not to carry out*” any nuclear weapon test explosion or any other nuclear explosion in the atmosphere, in outer space or underwater. It moreover determines that States Parties undertake to “*refrain from causing, encouraging, or in any way participating*” in the carrying out of any nuclear explosion in the atmosphere, in outer space or underwater.

Another treaty of relevance is the **Nuclear Non-Proliferation Treaty**. Articles 1 and 2 stipulate that each nuclear-weapon State Party undertakes not to transfer nuclear explosive devices and each non-nuclear-weapon State Party undertakes not to receive nuclear explosive devices or to manufacture or otherwise acquire nuclear explosive devices. The treaty was opened for signature in 1968 and entered into force in 1970.

The **Comprehensive Nuclear-Test-Ban Treaty** more broadly prohibits nuclear explosions “*at any place*”. Article 1 determines that States Parties undertake to prohibit and prevent any nuclear explosion and to refrain from causing, encouraging, or in any way participating in the carrying out of such an explosion. This treaty has been broadly ratified since its adoption in 1996 and 168 States have joined it. It has nevertheless not entered into force since several States, whose ratification is necessary for its entry into force, have not yet ratified the treaty.⁵⁶ Yet, some of these States have signed the treaty. Unlike ratification, a signature does not establish the consent of a State to be bound by a treaty,⁵⁷ but it does create an obligation of a State to refrain from acts that would defeat the object and purpose of the treaty.⁵⁸

The **Treaty on the Prohibition of Nuclear Weapons** in its Article 1 determines that States Parties undertake “*never under any circumstances*” to develop, test, produce, possess, stockpile, transfer, receive or use nuclear explosive devices. Furthermore, according to Article 4 States Parties that possess or control nuclear explosive devices “*shall immediately remove them from operational status, and destroy them as soon as possible*”. The treaty was adopted in July 2017 and opened for signature on 20 September that year. While it has not yet entered into force, it will pose an additional barrier for the use of NEDs for the States Parties once it becomes effective.

While it could be argued that the explosive use of a nuclear device for a planetary defence mission was not covered by the Limited Nuclear-Test-Ban Treaty and the Nuclear Non-proliferation Treaty, the formulations used in these treaties refer to nuclear explosions and nuclear explosive devices in general and thus encompass the case of nuclear devices and explosions in the context of planetary defence. The use of NEDs for the purpose of planetary defence is therefore prohibited for parties to the Limited Nuclear-Test-Ban Treaty since it involves a nuclear explosion in space close to, on or below the surface of a threatening asteroid or comet. Moreover, the transfer of nuclear explosive devices by nuclear-weapon States parties and the reception, manufacturing, or acquisition of such devices by non-nuclear-weapon States parties in the process of a planetary defence mission is prohibited under the Nuclear Non-Proliferation Treaty.

⁵⁶ For an overview of the status of signatures and ratifications see: www.ctbto.org/the-treaty/status-of-signature-and-ratification/.

⁵⁷ See generally Art. 14 Vienna Convention on the Law of Treaties. For the Comprehensive Nuclear-Test-Ban Treaty see Arts. XI and XII.

⁵⁸ Art. 18 Vienna Convention on the Law of Treaties. Note UNSCR 2310 of 23 September 2016 para. 4 affirms that any nuclear explosion would defeat the object and purpose of the Comprehensive Nuclear-Test-Ban Treaty.

The above analysis applies also in cases where it is envisaged to deploy one or several spacecrafts with a deflection capability in orbit as a precautionary measure. The stationing of NEDs in outer space is forbidden by Article IV of the Outer Space Treaty, which prohibits the placement of objects carrying nuclear weapons or weapons of mass destruction in orbit around the Earth, the installation of such weapons on celestial bodies as well as their stationing in outer space in any other manner. As regards the stationing of NEDs on Earth, the Nuclear Non-Proliferation Treaty is of relevance, as it prohibits non-nuclear-weapon State Parties from receiving, manufacturing or otherwise acquiring nuclear explosive devices.

3.3. Other relevant legal considerations

3.3.1. Export Control

If a planetary defence mission is undertaken by multiple States in collaboration, they may wind up needing to share some technology or equipment. Doing so could implicate the export control laws of the affected States and the procedures of international export control regimes in which they participate. However, planetary defence raises no ‘special’ aspects of that problem, beyond the usual (and often quite complex and sensitive) array of export control practices, and any specific questions about export controls would depend very heavily upon the particular facts of a future situation. Therefore, this report will not delve into that set of issues.

3.3.2. International environmental rules applicable to planetary defence missions

Environmental provisions can be found in Article IX of the Outer Space Treaty, which requires States Parties to carry out the exploration of outer space so as to avoid its ‘harmful contamination’ and, where necessary, to adopt ‘appropriate measures’ for this purpose.

In addition, several non-legally binding instruments set forth technical and/or safety standards, which could be of relevance in the context of planetary defence missions. The various space debris mitigation standards and guidelines that have been developed at the international level can give guidance in this regard. They are aimed at preventing damage on Earth through the impact of space debris objects that do not burn up completely when entering the Earth’s atmosphere, as well as damage of and interference with other space objects in Earth orbit caused by space debris. These include for instance the Space Debris Mitigation Guidelines of the Inter-

Agency Space Debris Coordination Committee (IADC),⁵⁹ the COPUOS Space Debris Mitigation Guidelines⁶⁰ and the Standard on Space Debris Mitigation Requirements of the International Organization for Standardization (ISO).⁶¹ They set forth design and operational measures for the limitation of debris generated during normal operations, the minimisation of the potential for on-orbit break-ups, the avoidance of intentional destruction, the prevention of on-orbit collisions, and post-mission disposal. In this regard, the Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space could be of relevance.

Moreover, the COPUOS Principles Relevant to the Use of Nuclear Power Sources in Outer Space⁶² and the COPUOS/International Atomic Energy Agency Safety Framework for Nuclear Power Source Application in Outer Space⁶³ are of importance. In particular, provisions contained in the Nuclear Power Source Principles regarding criteria for safe use (Principle 3), safety assessments (Principle 4), as well as notification, consultations and assistance to States (Principles 5-7), should be taken into account. Furthermore, guidance contained in the Safety Framework for Nuclear Power Source Application in Outer Space concerning the development of safety policies and processes, the verification of justification for the use of space nuclear power sources, the establishment of authorisation processes and emergency preparedness and response strategies, the conduct of risk assessments and the development of technical safety competences is of relevance in the context of planetary defence missions.

These provisions and instruments can give guidance to States with regard to the use of planetary defence methods and should be taken into account when planning and conducting planetary defence missions. They do not necessarily prohibit planetary defence methods, but they establish restrictions and conditions for their use.

⁵⁹ IADC Space Debris Mitigation Guidelines, IADC-02-01, Revision 1, 2007.

⁶⁰ COPUOS Space Debris Mitigation Guidelines, 2007.

⁶¹ International Organization for Standardization, Space systems - Space Debris Mitigation Requirements, ISO 24113, May 2011.

⁶² Principles Relevant to the Use of Nuclear Power Sources in Outer Space, UN General Assembly Resolution 47/68 of 14 December 1992.

⁶³ COPUOS Safety Framework for Nuclear Power Source Application in Outer Space, May 2009, A/AC.105/934.

3.4. Conclusion

From the analysis above, it can be concluded that the legality of planetary defence methods under international law needs to be taken into consideration when planning and carrying out planetary defence missions, as well as when employing planetary defence methods as precautionary measures. International law does not impose any special restrictions upon most of the potential planetary defence methods (including the slow push/pull methods and most of the impulsive ones). For those techniques, the general body of space law provides rules about malfunctions, failures and damage. Regarding nuclear explosive devices, however, Article IV of the Outer Space Treaty does impose some special rules as analysed in this report. Moreover, the prohibition of nuclear explosions in outer space under the Limited Nuclear-Test-Ban Treaty and the prohibition of the transfer, reception, manufacturing or acquisition of nuclear explosive devices under the Nuclear Non-Proliferation Treaty need to be respected. Furthermore, environmental considerations, including Article IX of the Outer Space Treaty, as well as non-legally binding safety standards and principles, such as guidelines on space debris mitigation, and the use of nuclear power sources in outer space, also need to be taken into account when conducting planetary defence missions.

The analysis also shows that the potential applicability of planetary defence devices not only against NEOs but also against other targets could raise political concerns at the international level. Broad international cooperation and information sharing with regard to the planning and conduct of planetary defence missions could enhance transparency and confidence among States and avoid mistrust and misperceptions at the international level. In addition, the development of generally agreed, objective and transparent criteria for the selection of planetary defence devices and technologies as well as for the decision to undertake response action could reduce international legal and political concerns. In this context, especially the prohibitions regarding NEDs need to be taken into account. Moreover, safety standards and processes for the conduct of planetary defence missions and the use of planetary defence devices could be elaborated. In this regard, the Principles on the Use of Nuclear Power Sources in Outer Space and the Safety Framework for Nuclear Power Source Application in Outer Space could be used as guidance.

The use of planetary defence methods in violation of international law will be discussed in the following chapters.

4. Responsibility

4.1. Introduction

The law of State responsibility is relevant to planetary defence. ‘Responsibility’ can be understood in an ordinary sense as simply denoting ‘obligation’. In the present chapter, the term is treated as addressing a specific legal concept, according to which responsibility describes the situation resulting from a violation of international law. Such violation of an international legal obligation leads to the international responsibility of the State (or international organization) that has breached that norm.

The law of State responsibility details the conditions for, exceptions from, and consequences of State responsibility, as well as the rules for its invocation etc. The International Law Commission’s Articles on State Responsibility (ARSIWA)⁶⁴ reflect customary international law and address ‘internationally wrongful acts’ of a State. According to Article 2 of the ARSIWA, such an internationally wrongful act of a State is defined as “*conduct consisting of an action or omission [that]: (a) is attributable to the State under international law; and (b) constitutes a breach of an international obligation of the State.*” These legal principles are also largely applicable to the conduct of international organizations, for which the International Law Commission has developed a specific set of rules.⁶⁵

There is a three-fold significance of State responsibility law for the issue of planetary defence that is discussed in the following sections. First of all, the very basic premise of responsibility needs to be applied to planetary defence missions since any violation of an international obligation in the course of a planetary defence mission leads to the answerability of the respective State and may provide the basis for claims for compensation (see Section 4.2). Secondly, there are certain instances in which States may not be considered having wrongfully violated international law (‘circumstances precluding wrongfulness’), even though not acting in compliance with international law. Applying these instances to planetary defence merits reflecting on the possibility for States to resort to certain, otherwise illicit planetary defence methods, without being considered as having committed an internationally wrongful act (see

⁶⁴ See draft articles on Responsibility of States for Internationally Wrongful Acts, in: un Doc. A/56/10, Report of the International Law Commission, fifty-third session (23 April–1 June and 2 July–10 August 2001), para. 76.

⁶⁵ See text of the draft articles on the responsibility of international organizations, in: UN Doc. A/66/10, Report of the International Law Commission, sixty-third session (26 April–3 June and 4 July–12 August 2011), para. 87.

Section 4.3). Thirdly, international space law embodies specific provisions on State responsibility relating to activities of non-governmental entities (see chapter [4.4. The role of non-governmental entities and corresponding legal considerations](#)).

4.2. Responsibility for violating international law in the course of a planetary defence mission

4.2.1. Being internationally answerable: The basic premise and its consequences

Violating international law gives rise to an obligation to answer internationally for the violation. This basic premise that a State breaching a legal rule can be held accountable is at the core of the legal concept of State responsibility. States are obliged to act in accordance with their international legal obligations. Naturally, the same rules apply to space activities, including planetary defence missions, which must be carried out in accordance with international law, as also set forth in Article III of the Outer Space Treaty.

Other chapters of this report discuss law potentially applicable to planetary defence activities. This includes, for example, possible obligations to inform about NEO threats in certain circumstances, to refrain from certain planetary defence methods due to their incompatibility with international law, and abide by decisions of the UN Security Council, as well as other obligations. A State or international organization that fails to meet its obligations bears international responsibility.

The consequences of such responsibility are manifold. The State remains, first of all, under the obligation to cease the wrongful conduct and to pledge non-repetition (Art. 29, 30 ARSIWA). A responsible State is also requested to make reparation, in the form of restitution, which means to re-establish the situation that existed before the wrongful act, compensation for damage caused by the wrongful act and/or satisfaction for the injury, as the case requires (Art. 31 and 34-37 ARSIWA). For example, if a failure to inform of a NEO threat, to the extent this is required under international law, leads to injury (because as a consequence of this failure planetary defence measures were not taken, or not taken early enough), such losses are to be made good by providing compensation.

4.2.2. The difference between ‘responsibility’ and ‘liability’ in international law

State responsibility describes the consequences arising from a breach of an international obligation. Responsibility therefore requires a wrongful act. While responsibility may be the basis for a claim for compensation as one form of reparation, its prime objective is to ensure the respect for international law. In contrast, State liability focuses exclusively on compensation. It describes the compensation for, and arises from the causation of damage. In some cases, as will be explained below, liability for damage requires fault (including negligence), while in other cases, of particular relevance in the context of planetary defence, the occurrence of damage in itself suffices to trigger liability.

The difference between the notions of responsibility and liability in international law can be summarized as follows: a State may be held internationally responsible for a wrongful act although there is no material damage; a State may be held internationally liable for damage caused although it did not act wrongfully.

4.3. Circumstances precluding wrongfulness

4.3.1. Exceptionally justifying non-compliance

As pointed out earlier, some planetary defence methods may be considered an adequate means for addressing the dangers of a NEO impact, whereas their application, at the same time, would amount to a violation of an international obligation (for example, when it comes to the use of NEDs). State responsibility law acknowledges that there may be circumstances in which compliance with international law is not feasible. Such instances can be expected to occur only very rarely. Utmost care should be applied in resorting to the invocation of circumstances precluding wrongfulness in order to limit their operation to exceptional cases in the interest of maintaining the full validity of international law. The International Law Commission in its ARSIWA has compiled rules that have been recognized as excusing or justifying non-compliance by States with their international obligations (Art. 20-25 ARSIWA). In the case of planetary defence methods, the circumstances of consent, distress and necessity are of potential relevance.

4.3.2. Consent

The wrongfulness of a particular act that is not in conformity with international law is excluded, if a State has given its consent to the commission of this act, according to Article 20 of the ARSIWA. Wrongfulness is excluded only to the extent that the conduct remains within the limits of the consent and only in relation to the State that has given its consent. If a State, in the event of a NEO impact threat, has agreed to the application of a particular planetary defence method that violates international law by another State, such application may no longer be regarded as wrongful in the relation between these two States.

However, *vis-à-vis* third States, to which the obligation is owed and which have not consented to the planetary defence mission, the wrongfulness is not excluded. Since the international legal obligations, which may potentially be breached by a planetary defence mission, do not have a bilateral character, but are owed to a group of States (or even all States), the consent of a single State is naturally not sufficient for excluding the wrongfulness in relation to third States. For example, a possibility for expressing broad consent to a particular planetary defence mission would be for UN Member States to adopt a respective UN General Assembly resolution.⁶⁶

4.3.3. Distress

According to Article 24 Para. 1 of the ARSIWA, the wrongfulness of an act of a State not in conformity with an international obligation is precluded “*if the author⁶⁷ of the act in question has no other reasonable way, in a situation of distress, of saving the author’s life or the lives of other persons entrusted to the author’s care*”. Thus, in situations where the lives of persons are threatened by the possible impact of a NEO, the use of a planetary defence method in violation of international law could be justified if there is “*no other reasonable way*” of saving the lives.

On the other hand, in practice, distress is usually invoked in specific situations when the state agent, who acts against international law, has related persons who are in danger (e.g. emergency situations related to aircrafts or ships). An application to more general situations of emergency, including an impact threat, may be more difficult to argue. Furthermore, distress cannot be invoked if the act in question is likely to create a comparable or greater peril (Art. 24, Para. 2 ARSIWA) and it can only preclude wrongfulness where the interests sought to be protected

⁶⁶ Considerations for Decision Processes, including through the UN General Assembly, are discussed in chapter on [Considerations for Decision Bodies](#).

⁶⁷ The author of the wrongful act is the State having violated its international legal obligation.

clearly outweigh the other interests at stake in the specific case.⁶⁸ Thus, to the extent that distress can be invoked in order to justify the use of a planetary defence method which is not in conformity with international law, the planetary defence mission must not endanger the population of other States in a comparable or even greater manner. Both the harms avoided as well as the harms inflicted must be taken into account, while the assessment of the risks involved may be difficult in practice.

4.3.4. Necessity

Necessity under Article 25 of the ARSIWA is another circumstance that can preclude the wrongfulness of an act which is not in conformity with an international obligation.⁶⁹ However, according to Article 25 Para. 1, necessity can only excuse conduct which is “*the only way for the State to safeguard an essential interest against a grave and imminent peril*” and which “*does not seriously impair an essential interest of the State or States towards which the obligation exists, or of the international community as a whole.*” The extent to which an interest is ‘essential’ depends on the circumstances of the particular case.⁷⁰ Necessity can only preclude the wrongfulness of an act, if the interest relied on outweighs all other considerations, in particular, the competing interests of the other States concerned.⁷¹ Moreover, necessity can only be invoked successfully if the interest is threatened by a grave and imminent peril which is objectively established and not merely apprehended as possible and if the action taken is the only way available to safeguard the interest.⁷² If, for instance, a State seeks to protect vast parts of its territory from devastation by a NEO impact, this would certainly constitute an essential interest. Whether the NEO impact and its consequences constitute a grave and immediate peril, depends on the individual case. It should be beyond doubt that certain types of impacts are, in fact, of such magnitude. However, the State could only use a planetary defence method in violation of international law, if it does not put the territory and population of other States at risk, if the NEO impact threat is clearly and objectively established and if there is no other method available to mitigate the impact.

⁶⁸ See Responsibility of States for Internationally Wrongful Acts: Text of the Draft Articles with Commentaries Thereto, in: UN Doc. A/56/10, Report of the International Law Commission, fifty-third session (23 April-1 June and 2 July-10 August 2001), para. 77, Commentary on Art. 24, subparas. 7-10.

⁶⁹ The state of necessity is a ground for precluding wrongfulness recognized by customary international law. Case concerning the Gabčíkovo-Nagymaros Project (Hungary/Slovakia), Judgment, ICJ. Reports 1997, p. 7, para. 51.

⁷⁰ See Responsibility of States for Internationally Wrongful Acts: Text of the Draft Articles with Commentaries Thereto, in: UN Doc. A/56/10, Report of the International Law Commission, fifty-third session (23 April-1 June and 2 July-10 August 2001), para. 77, Commentary on Art. 25, subpara. 15.

⁷¹ See *ibid.*, subpara. 17.

⁷² *Ibid.*, subpara. 15.

Under specific circumstances, violations of international obligations might thus be justified in the extreme situation of a NEO impact threat.⁷³ However, in practice it might prove difficult to conduct a comprehensive evaluation of whether in a concrete case the specific conditions for invoking circumstances precluding wrongfulness are met, such as whether the NEO threat constitutes a 'grave and imminent peril', whether a particular mitigation method is 'the only way' available to safeguard the interests endangered by the possible NEO impact and whether essential interests of other States are seriously impaired.

4.3.5. Consequences of invoking circumstances precluding wrongfulness

Should the invocation of a circumstance precluding wrongfulness be justified, the act of the State – *i.e.* the conduct that is not compliant with international law – is not regarded as being wrongful. However, the objective discrepancy between the conduct required under international law and the actual conduct persists, and the international law itself is not altered by the invocation of a circumstance precluding wrongfulness. As soon as the invoked circumstance ceases to exist, the State is obliged to return to lawful conduct (Art. 27 Lit. (a) ARSIWA). The assertion that a pending NEO impact constitutes a threat to an essential interest that outweighs any other considerations and that can only be adequately addressed by a specific planetary defence method, may be altered by the emergence of new facts, by becoming aware of previously unknown facts, or by reassessing existing facts. In such cases, it would no longer be possible to consider the application of such methods as not being wrongful conduct. This may be the case, if additional information on potential negative side effects of deploying the envisaged planetary defence method become known or other methods become available. The question of wrongfulness of the act is without prejudice to the question of compensation for any material loss caused by the act (Art. 27 Lit. (b) ARSIWA).

In case a dispute arises between States with regard to the conduct of a planetary defence mission, for example with regard to its lawfulness, the dispute is to be settled by peaceful means. These include for instance mediation, negotiation, arbitration and the judicial settlement of disputes by the International Court of Justice (Art. 33 UN Charter).

⁷³ In this context, reference should also be made to the Advisory Opinion of the International Court of Justice on the Legality of the Threat or Use of Nuclear Weapons. In this Advisory Opinion, the Court stated that it "*cannot conclude definitively whether the threat or use of nuclear weapons would be lawful or unlawful in an extreme circumstance of self-defence, in which the very survival of a State would be at stake*". See Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, ICJ. Reports 1996, p. 226, para. 105. While the Advisory Opinion applies to a specific situation, namely self-defence against an armed attack, which is an 'inherent right' of States (Art. 51 UN Charter), and not to a NEO impact threat, it can nevertheless support the argument that a use of planetary defence methods which is not in conformity with international obligations could be justified if it is, in extreme situations, the only way to safeguard the survival of a State or the entire planet.

Members of the United Nations may bring any dispute to the attention of the Security Council or of the General Assembly (Art. 35 UN Charter). The Security Council may recommend appropriate procedures. Legal disputes should as a general rule be referred by the parties to the International Court of Justice (Art. 36 UN Charter).

4.4. The role of non-governmental entities and corresponding legal considerations

4.4.1. Increasing role of non-governmental entities

The role of non-governmental entities – *e.g.* private (often commercial), non-state actors, universities, think tanks, non-profit non-governmental organizations (NGOs) – in space continues to grow. Initially, space activities were the exclusive domain of the public sector (governments and international organizations), not least due to the military and strategic significance of space.

The role of non-governmental entities is also indispensable in technology development. Beyond the classic, fully publicly financed procurement of space technology, there is more and more private investment in innovative technology driven by cooperation between the public and private sector in new ways. Building on the great potential of private sector involvement and investment, all of these possibilities may have precedential value for planetary defence missions.

On a very general level, there are many different roles that the non-state actors can assume in addressing the risks associated with NEOs (*e.g.* creating knowledge about planetary defence methods, awareness raising, civil protection, etc.).

In a narrower sense (*i.e.* with respect to the actual space mission for a planetary defence operation) the private sector could contribute through the provision of space technology (spacecraft, launcher, components, etc.). It could also directly contribute to the planetary defence mission by carrying out some mission elements or even the entire space mission, thus undertaking space activities. While parts of a mission, including essential ones, may be taken over by private actors, the mission itself would in all likelihood be carried out in the public interest by order of one or more governmental or intergovernmental entities.

4.4.2. The significance of Article VI of the Outer Space Treaty

The different roles that non-governmental entities play in addressing NEO impact risks imply that there are different legal issues at stake. Many of them are primarily subject to national law, such as the contractual relationships in procurement processes or those questions relating to the role of the private sector in civil protection activities.

From a public international law perspective, the private involvement in a planetary defence mission is of particular interest in its quality as a space activity. Such private conduct in space may include the launch or operation of the spacecraft or other mission-related asset. The various types of activities depend on the design of the particular mission.

Article VI of the Outer Space Treaty is relevant to private conduct in outer space, including for planetary defence missions. Non-governmental entities are explicitly mentioned in the provision:

“States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the Moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the Moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty. [...]”

4.4.3. Direct attribution of the conduct of non-governmental entities to a State

Article VI of the Outer Space Treaty is relevant in different ways. It has a significant bearing on State responsibility law, namely on attribution. Under general international law, ‘attribution’ means linking the wrongful conduct to a particular State. The conduct of private entities is, as a general principle, not attributable to a State under international law. Here is where Article VI of the Outer Space Treaty introduces a space-specific, additional attribution rule.⁷⁴ According to this rule, States are in any event internationally responsible for national activities (*i.e.* provided that there was a breach of an international legal obligation in the course of these activities), irrespective of whether the conduct in question is carried out by governmental agencies or non-governmental entities. Thus, there is a direct attribution of a private entity’s conduct to the respective State. The State shall be responsible for ‘national activities’ which means in the case

⁷⁴ Art. VI Outer Space Treaty can therefore be regarded as a ‘special rule’ of international law that takes precedence over the general rules of state responsibility law as set forth in Art. 55 ARSIWA.

of non-governmental entities activities of its nationals (natural or juridical persons, including private companies) or activities that are carried out from the territory of the State.

This rule is applicable to space activities, including planetary defence missions. The involvement of non-governmental entities in such missions by implementing (parts of) that mission means that should there be a violation of international law, this breach would be directly attributable to the corresponding State, thus entailing its international responsibility for the conduct of the private entity. With multilateral entities, determining which is the corresponding State or States could add a level of complexity. Potentially relevant rules of international law that are applicable to planetary defence missions are discussed in other chapters.⁷⁵ This means, in practical terms, that those States hold an interest in overseeing private activities in order to protect themselves from being internationally responsible for norm violations attributed to them.

4.4.4. Authorization and continuing supervision of non-governmental activities

States are also bound to assure the compliance of the conduct of national space activities, including those of non-governmental entities, with international law according to Article VI Outer Space Treaty. From the direct attribution rule it follows readily that States are obligated under the second sentence of Article VI Outer Space Treaty to authorize and continuously supervise the space activities of non-governmental entities. In view of its international accountability, it is in the State's own interest to closely involve itself in the activity by monitoring and regulating, as necessary, the conduct of non-governmental entities.

Authorization and continuing supervision are usually implemented through national space legislation. Many States have national space laws for this purpose⁷⁶ and a growing number of States are considering such legislation. The laws are meant to fulfil the international obligations of States and also to facilitate and support private space activities by providing a predictable, stable and enabling regulatory environment. Most of these space laws include the requirement for private entities to seek prior authorization as well as the ongoing monitoring of private activities in outer space.⁷⁷ In a dedicated working group of the Legal Subcommittee of COPUOS,

⁷⁵ See, for example, chapters [2](#), [3](#), and [6](#).

⁷⁶ An overview on existing national space legislation is provided on the websites of the United Nations Office for Outer Space Affairs: United Nations Office for Outer Space Affairs, National Space Law Collection, www.unoosa.org/oosa/en/ourwork/spacelaw/nationalspacelaw/index.html (retrieved 23 May 2018).

⁷⁷ United Nations Office for Outer Space Affairs also offers a database highlighting the different regulatory categories of national space laws, the latest version dating from 2014: UN Doc. A/AC.105/C.2/2015/CRP.5, Schematic overview of national regulatory frameworks for space activities, 17 March 2014.

the Subcommittee worked to identify the ways in which States regulate governmental and non-governmental space activities. As a result of this work, the United Nations General Assembly in 2013 adopted a resolution on national space legislation,⁷⁸ in which it recommended States to consider certain elements when enacting national space laws. Authorization and continuing supervision counted among these elements (in particular No. 2-5 of that Resolution). Apart from ensuring the implementation of the international obligations of the authorizing/supervising State, the recommendations also emphasize the function of national space law in ensuring the safety of space operations by implementing safety standards and provisions, for example those related to the mitigation of space debris (No. 5 of that Resolution).

When it comes to the involvement of non-governmental entities in planetary defence missions, it is clear that private space activities in the scope of these missions must be made subject to governmental oversight and comply with applicable national space legislation (*i.e.* authorization and continuing supervision by the appropriate State). In this way, the responsible State would ensure that the private activities are carried out in compliance with the international obligations of that State. National legislation also serves to ensure a safe implementation of the mission by requiring compliance with the existing safety standards in order to reduce, to the maximum extent possible, the risk of mission failure and ensuing damage.

4.5. Conclusion

State responsibility addresses the international obligations of States arising from wrongful conduct and specifies the consequences for not acting in compliance with their international legal obligations. Since there are numerous obligations that are also relevant to planetary defence missions, State responsibility cannot be discussed without reference to the obligations of States relevant to NEOs and corresponding planetary defence missions that are addressed in other chapters of this report (e.g. to the process for agreeing on a planetary defence mission, rules applicable to planetary defence methods etc.).

Unlawful conduct would not be regarded as internationally wrongful if it is justified by circumstances precluding wrongfulness, such as consent, distress, and necessity. While utmost care must be applied when resorting to these circumstances and they can only be used in specific cases, State responsibility law could offer a path towards deploying certain planetary defence

⁷⁸ See UN General Assembly Resolution 68/74, Recommendations on national space legislation relevant to the peaceful exploration and use of outer space, 16 December 2016.

methods that would be contrary to international law. However, a subjective assessment of the situation might lead to legal uncertainty with regard to the justification of the conduct of a planetary defence mission that is not in conformity with international law. SMPAG work in developing objective criteria for assessing the perils of a NEO impact threat as well as the appropriateness of the respective defence methods for addressing them, would be useful in this regard.

Private activities continue to assume an increasingly important role in the space sector, which may also hold true for future planetary defence missions. Non-governmental entities may not only be involved as a supplier of space systems, but may themselves carry out parts of the, or even the entire, mission. In this regard, private involvement in NEO activities is not different from private involvement in other types of space activities, from the point of view of international space law. Also in the NEO context, non-compliance with international law would be directly attributable to the State(s) behind the private entity. In addition, States would need to authorize and continuously supervise private space activities.

Beyond the *status quo*, any further legal development related to planetary defence missions, including the possible development of safety standards, should be taken into account for considerations of State responsibility as well as for the private involvement in planetary defence missions discussed in this chapter.

5. Liability

5.1. Introduction

5.1.1. Liability for damage caused by space objects: burden and protection

Considering the complexities and the risks at stake in a planetary defence context, the issue of liability for damage caused deserves appropriate attention. While liability would generally only be triggered *after* the occurrence of damage resulting from a planetary defence mission,⁷⁹ adequate consideration of the circumstances and implications of liability, particularly liability towards third parties, should be given *before* any planetary defence mission is undertaken.

Liability can be generally described as the duty to compensate for damage.⁸⁰ Liability serves as a protection for those having to bear potential negative consequences of an action, but is equally a 'burden' on the one acting.⁸¹ The idea of a 'victim-oriented' protective approach is particularly important in international space law. As will be shown below, both Article VII of the Outer Space Treaty and the Liability Convention⁸² have been drafted based on the understanding that the freedom of States to carry out space activities shall not be to the detriment of others.

A planetary defence action may ultimately serve to protect States beyond those carrying out the action. Planetary defence could thus be viewed as a space activity based on the capacities of a few, but for the benefit of many. Nevertheless, applicable liability regimes should be duly considered as they may be triggered regardless of good intention or overall benefit of a planetary defence mission. As will be shown in this chapter, the consequences of liability could be mitigated or contained primarily through the establishment of an appropriate international understanding by means of legal and / or political instruments. The likelihood of achieving this will ultimately be linked to the degree to which balance and coordination of interests can be reached.

⁷⁹ E.g. where, after a partially failed mission, a NEO damages an area different to the one originally predicted.

⁸⁰ As such, liability is not a penalty or retribution. Instead, it is a legal consequence for acts which, per se, are not necessarily unlawful.

⁸¹ Particularly in the case of a planetary defence mission, the potential liability could be immense - so large that it might deter an actor from attempting the mission if it was not itself in direct and immediate danger.

⁸² Convention on International Liability for Damage Caused by Space Objects, adopted by UN General Assembly Resolution 2777 (XXVI) of 29 November 1972, entry into force on 2 September 1972, UNTS 961.

5.1.2. The regulation of international liability for space activities

The duty to compensate others for damage suffered can arise in multiple forms and regulatory contexts, one of which is the *international liability of launching States to pay compensation for damage caused by their space objects*. This type of liability is to be primarily considered in the context of planetary defence. The prime rule for the liability of launching States is established through Article VII of the Outer Space Treaty:

“Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the Moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the Moon and other celestial bodies.”

The Liability Convention, an international treaty in its own right,⁸³ emanates from Article VII of the Outer Space Treaty and details the regulation of liability for damage caused by space objects, including a catalogue of terms defined and a claims procedure. Articles II and III of the Liability Convention establish two different liability regimes depending on the geographical occurrence of the damage:

- a) Damage caused by a space object on the surface of Earth (or to aircraft in flight)

*“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. II Liability Convention)

In these cases, a launching State⁸⁴ is **absolutely liable** to pay compensation – *i.e.* regardless of fault. The mere occurrence of damage, causally inflicted by a space object, leads to liability, *i.e.* the obligation to compensate, of the launching State.

Consequently, a State whose space object causes damage on Earth will have to pay compensation for that damage independently of any fault, any omission, wrongful act or the breach of an international obligation. The Liability Convention thus grants particular protection to those (States) suffering damage on Earth and not involved in that space activity.

⁸³ The Liability Convention is legally independent from the Outer Space Treaty: State Parties to the Liability Convention do not necessarily have to be State Parties to the Outer Space Treaty and vice versa.

⁸⁴ For the definition and discussion of the term ‘launching State’, see [5.2.2.](#)

b) Damage caused by a space object elsewhere than on the surface of the Earth

*“In the event of damage being caused **elsewhere than on the surface of the Earth** to a space object of one launching State or to persons or property on board such a space object by a space object of another launching State, the latter shall be liable only **if the damage is due to its fault** or the fault of persons for whom it is responsible.”* (Art. III Liability Convention)

In case of damage caused by a space object to a space object of another launching State (or to persons or property on board such a space object) while **in outer space**, the Liability Convention refers to fault-based liability. It thus does not grant particular protection in the relations between equal State actors, but protects those (States) suffering damage only to the extent that this damage was caused by fault.

The regulation of liability in space law represents a comparatively detailed and innovative liability regime based on the understanding that spaceflight is a hazardous undertaking, the freedom of which comes at the price of accepting the requirement to compensate others for resulting damage. Appreciating this background is relevant in the context of planetary defence, which, even by the measure of contemporary spaceflight, may necessitate using novel technologies and undertaking action that is even more hazardous.

Focusing on launching State liability under international space law does not minimize other norms of applicable international law; both space law and general international law provide a potential basis for claims for compensation of damage suffered. However, as long as the specific perspective of space activities is to be considered, the regulation of liability under international space law is applicable and, in principle, overrides any more general international legal norms regulating aspects of liability.

5.1.3. Whom to compensate

Those suffering damage as the direct result of a space activity can be divided in two main groups: cooperation partners associated with the space activity or third parties without relation to the space activity. Consequently, the types of liability, their legal regulation and their practical consequences have to be distinguished.

5.1.4. Liability between partners cooperating for planetary defence

Not considered here are cases of liability between those States acting together to carry out a planetary defence mission, and cooperating under a (legal) instrument entered into for that

specific purpose.⁸⁵ The consequences of such ‘contractual damages’ are typically defined in the appropriate (legal) instruments established between the respective parties and thus would follow a bilateral, case-by-case definition of rights and duties. It is common for international cooperation to include cross-waivers of liability⁸⁶ between the involved parties. An example of multilateral cooperation under an international treaty in the context of a complex space activity is the Intergovernmental Agreement of 1998 on the International Space Station (IGA).⁸⁷ Like other space cooperation agreements, the IGA establishes a cross-waiver of liability between the parties.⁸⁸ In fact, cross-waivers have grown into a widely applied instrument to regulate the consequences of damage caused by and between cooperation Partners. It should be noted, however, that they apply only to and between the parties to such agreements, while they do not (and cannot) cover third party liability.⁸⁹

5.1.5. Liability towards third parties

Third party liability generally refers to the duty to compensate for damage in relation to another (natural or legal) person suffering the damage and who is not in a contractual relationship with the one causing the damage (in some circumstances also referred to as an ‘innocent bystander’). At the international level, this type of liability is referred to as *international third party liability*, *i.e.* the liability of one or more State(s) for damage inflicted on one or more other State(s), whereby the ‘victim’ States are innocent bystanders.⁹⁰ This form of liability may be triggered

⁸⁵ An example of such liability may be a delay in delivering the planetary defence spacecraft (payload) by State 1 which results in the necessity to reschedule the launch and therefore causes additional cost to State 2 providing the launch vehicle for the common planetary defence mission.

⁸⁶ Cross-waivers represent a legal instrument found in several international space cooperation agreements whereby the parties agree not to sue each other for damages suffered under their cooperation, except under certain circumstances.

⁸⁷ The International Space Station Intergovernmental Agreement, signed on 29 January 1998 by the United States of America, Canada, Japan, the Russian Federation and 10 Member States of the European Space Agency (Belgium, Denmark, France, Germany, Italy, The Netherlands, Norway, Spain, Sweden and Switzerland).

⁸⁸ Article 16 established a cross-waiver of liability between the Partners and their ‘related entities’ for damage arising out of activities relating to the building and utilization of the ISS: A Partner shall not make any claims against another Partner or against its related entities (*i.e.* contractors and subcontractors at all tiers, users or customers at all tiers, and contractors and subcontractors of the users and of the customers at all tiers) for damages that it may suffer from ISS-related activities, save for a list of defined exceptions.

⁸⁹ In fact, international treaties including cross-waivers of liability usually make clear by means of a specific provision, declaratory in its nature, that cross-waivers do not cover third party liability.

⁹⁰ Examples of such liability may be - depending on circumstances and legal appraisal - a collision between the planetary defence spacecraft and another spacecraft, or, possibly, damage caused by a deviated NEO to the territory of a previously unaffected State.

after the occurrence of damage caused by a planetary defence mission and will, therefore, be further detailed and described below.

5.1.6. Liability towards States requesting a planetary defence action

Planetary defence may also raise the somewhat novel situation of a State that requests, supports or endorses a respective mission, but does not participate in it. If an expansive interpretation were applied to the concept of ‘procuring’ a launch under the Liability Convention, such a State could be regarded as a launching State, incurring the associated international liability. On the other hand, a more narrow understanding of the term ‘procure’ would not classify such a State as being a launching State, but it seems equally problematic to view it as a traditional ‘third party’ entirely disconnected from the mission and entitled to full protection under the Liability Convention. This question will have to be addressed on a case-by-case basis, depending upon the immediate facts and the respective legal interpretation.

5.2. Third party liability for space activities

5.2.1. Discussion of the elements of liability in the light of planetary defence

For a State to be held liable under international space law, the following elements need to be present:

1. qualification as a ‘launching State’;
2. damage;
3. a direct link between the space activity and the damage (‘causality’ or ‘causal chain’);
4. fault of the actor in case of damage caused in outer space.⁹¹

In the following, the above-listed key elements of liability will be explained in more detail.

⁹¹ Under certain circumstances (as in the case for certain damage caused by space objects), the fourth component, fault, may be omitted, resulting in the notion of ‘absolute liability’ or ‘strict liability’, as will be further detailed below. In the latter case, it is sufficient for triggering liability that (1) there is a launching state (2) damage has occurred and (3) this damage can be causally linked to an actor. Absolute liability plays an important role in spaceflight and should, therefore, adequately be taken into account in the context of planetary defence.

5.2.2. Element 1: The launching State

An important aspect of State liability is the ‘launching State’, a concept central and specific to international space law. On several occurrences, legal attributions and consequences – including the one of liability for damage – are not related to the owner or operator of a space object, but to the launching State. In other terms, on the international plane it is almost always the launching State being held liable for damage caused by a space object, even though in practical terms the damage may have been caused by a private operator.⁹² While a government may recover from such private operator part of the compensation paid to a third party, it can never pass on its liability under international law to the operator altogether.

International space law offers a distinct ‘formula’ to define the launching State(s) in relation to any given space object. This formula⁹³ reads as follows:

- a. The State which launches a space object.
- b. The State which procures the launch of a space object.
- c. The State from whose territory a space object is launched.
- d. The State from whose facility a space object is launched.

If a State fulfils one or more of the above criteria in relation to a given space object (e.g. a planetary defence spacecraft), it qualifies as one of the space object’s launching States.⁹⁴ The same is true if two or more States meet the criteria in relation to the same space object, in which case they will collectively become the space object’s launching States. The quality of ‘launching State’ thus arises from factual circumstances and their legal interpretation, not from an act accepting such status.

It is essential to consider that any launching State, in relation to a given space object:

- remains the launching State for the lifetime of the space object and beyond and
- may become liable for damage caused by the space object (however, depending on the location of the damage, additional criteria may apply; see below).

⁹² See Article VI Outer Space Treaty. More information can be found in the Chapter *The role of non-governmental entities and corresponding legal considerations*.

⁹³ The ‘formula’ appears in Art. VII Outer Space Treaty and Art.1 Liability Convention, inter alia.

⁹⁴ While option c. – the territory of launch – can usually be established without difficulty, options a., b. and d. have given rise to questions and, in some cases, uncertainty as to which State is to be considered a launching State in relation to a space object. In particular the term ‘to procure’ and its meaning are debated in academic circles. Bearing in mind the ‘victim-oriented’ approach of international space law, the interpretation of what qualifies as the ‘procurement’ of a given space object launch may be rather extensive than restrictive.

5.2.3. Element 2: Damage

International space law defines the term ‘damage’ as “*loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organizations.*”⁹⁵ In the context of planetary defence mission-induced damage, it is likely that precisely these types of damage would occur.⁹⁶

5.2.4. Element 3: Causation

Causality is central to the question of liability: the duty to compensate for damage depends on the demonstration that the damage results from a given space object. In other words, liability under international space law is dependent upon the occurrence of a “*damage caused ... by a space object*” (Art. II and III Liability Convention). As long as damage is directly inflicted by a human-made space object (spacecraft) and this can be proved, the question of causation should not present a legal problem. This would be the case, for example, if a spacecraft bound to deflect a NEO collides with another spacecraft or impacts the surface of Earth upon atmospheric re-entry.

The situation becomes legally more complex if it is a NEO that causes damage as the result of a human-induced intervention *through* a space object. This would be the case, for example, if a planetary defence mission alters an asteroid’s trajectory, resulting in the asteroid damaging a State that would not otherwise have been affected. Here, it must be discussed to what extent this would still satisfy the requirement “*caused by a space object*” in the meaning of space law, *i.e.* to what extent, if at all, damage caused by a natural object ultimately could be attributed to a launching State, triggering the latter’s liability.

For the condition of causality to be satisfied, the damage must be attributable to the incident caused by the space object, foreseeable, perhaps reasonably foreseeable, and not too remote.⁹⁷ If these conditions are fulfilled, damage caused by a disrupted NEO (*i.e.* after being targeted by a planetary defence mission) could indeed be regarded as damage caused by the spacecraft carrying out the mission and thus would entail the liability of the launching State(s) of that

⁹⁵Art. 1(a) Liability Convention.

⁹⁶ The discussion as to what extent immaterial damages may be included in the notion of damage is therefore considered being of lesser relevance here.

⁹⁷ If the damage is caused indirectly through a chain of events that are initiated by the space object, it must be such that it would not have occurred, had the space object not caused the initial damage.

spacecraft.⁹⁸ In other words, indirect causation may likely be sufficient to trigger liability and thus be legally actionable.

5.2.5. Element 4: Fault of the actor⁹⁹

With regard to damage that occurs *in outer space* as a result of a planetary defence mission, Article III Liability Convention establishes that holding a launching State liable requires the existence of fault on the side of that launching State. However, the Liability Convention does not provide a definition of the term ‘fault’.¹⁰⁰

In absence of detailed regulation and practice, it remains to be clarified what constitutes ‘fault’ in relation to space operations in outer space and how measures by which fault may be established can be appropriately identified. Although damage caused by a planetary defence activity, either by the space object or the deflected NEO, to other space objects in outer space may be less likely or of a lesser size or impact than on Earth, it will be important to discuss and develop a general understanding of what may constitute fault / negligence in terms of:

- planetary defence space mission planning and implementation (execution);
- choice of planetary defence methods;
- planetary defence standards, procedures and requirements; and
- international coordination and information sharing.

Those elements may be indicators of what is to be considered desirable, reasonable and responsible behaviour in the conduct of planetary defence activities and thus establish a standard of care against which the behaviour of a launching State can be assessed. So far, neither legally binding nor non-binding instruments exist that specifically cover the conduct of planetary defence missions and that could establish, or from which there may be deduced, a standard of care to evaluate whether a planetary defence activity has been carried out in a diligent or a negligent manner. Such standards may be developed in the future to help clarify

⁹⁸ If a deflected NEO causes damage to one or more States – regardless of where that damage occurs – the launching States of the planetary defence mission may therefore be held liable for such damage under the condition that the original planetary defence action (*i.e.* spacecraft-asteroid interaction) was the damage’s obvious and not too remote root cause. It shall be noted, however, that any legal consequences ultimately depend on the actual context and its interpretation by those competent to do so.

⁹⁹ Note that this element is only to be considered in case of damage caused in outer space.

¹⁰⁰ The notion of fault as referred to in Article III is also not common in international law, which usually refers to the breach of international obligations rather than to fault. Moreover, there is no commonly accepted definition of the term ‘fault’ in international law today, although prevailing scholarly opinion would include acts of gross negligence and wilful misconduct hereunder.

the notion of fault. An international understanding in this respect may thus protect both those carrying out planetary defence activities and those suffering damage from such activities.

5.2.6. Liability for false warnings

Liability for false warnings as well as for not undertaking action in relation to NEO threats is more difficult to establish. In all likelihood, these are not questions to be discussed under international space law, and particularly not in the context of third party liability under the Outer Space Treaty and Liability Convention.

Consequences of false warnings may have to be assessed using general notions of international responsibility (for internationally wrongful acts) and international liability (for damage). Therefore, NEO threat warnings may be treated similar to warnings regarding the likelihood of (other) natural disasters, tsunami warnings serving as a potential analogy. As long as States do not willingly or in a grossly negligent manner provide false data, it will be difficult to hold them internationally responsible or liable, it being understood however that any concrete legal appraisal depends on the context and circumstances and no general rule or conclusion can therefore be established. Criteria for impact response action that are currently being developed by IAWN and SMPAG could help to avoid false warnings by setting technical and procedural standards.

5.3. Measures to mitigate the risk of being held liable

From the perspective of a launching State carrying out a planetary defence mission, the possibility of being held liable represents a risk. Consequently, the launching State would endeavour to mitigate this risk to the extent possible, particularly if the planetary defence mission ultimately would benefit the international community at large. Considering the interplay of interests, it seems important to discuss the mitigation of liability risks taking this risk-benefit-ratio into account, yet without compromising the protection of States suffering potential damage.

5.3.1. Measure 1: Agreement between launching States

Article V of the Liability Convention provides that in case there are two or more launching States, they shall be jointly and severally liable for any damage caused. Moreover, it stipulates that the participants in a 'joint launching' can conclude agreements among themselves regarding the apportioning (*i.e.* partition) of the financial obligation for which they are jointly

and severally liable.¹⁰¹ From the perspective of an individual launching State, the apportionment of possible financial consequences represents a risk mitigation method in relation to the possible financial consequences of third party liability. However, any such agreement could not rule out the third party liability in principle; it could merely regulate the consequences, not the circumstances.

In addition to the States directly carrying out a planetary defence mission, other States may also qualify as launching States of that same mission: States which are threatened by a NEO impact and which ask for, or agree to, conducting the mission may (as discussed in [5.1.6 Liability towards States requesting a planetary defence action](#)) be regarded as States ‘procuring’ the launch, by means of expansive interpretation of Article VII of the Outer Space Treaty and Article I of the Liability Convention.¹⁰² Such an assumption could be supported if the term ‘to procure’ were to be understood within the meaning of ‘to prompt / trigger’.¹⁰³

Under Article V of the Liability Convention, the launching States could thus conclude an agreement with regard to possible future liability issues in relation to third parties. Another direct result of such interpretation would be that the States asking for action would not count as ‘third parties’ or innocent bystanders any longer, for they would be considered as launching States of the same mission and thus no longer be the beneficiaries of the space law liability regime.¹⁰⁴

5.3.2. Measure 2: Agreement beyond the circle of launching States

Beyond the mechanisms of the Liability Convention, the risk to be held liable for third party damage may also be mitigated through seeking broad international agreement on how to deal

¹⁰¹ However, such agreements “shall be without prejudice to the right of a State sustaining damage to seek the entire compensation [...] from any or all of the launching States which are jointly and severally liable.” (Art. V, para. 2 sentence 3 Liability Convention).

¹⁰² On the interpretation of the term ‘to procure’, see: Kerrest, A., and L. J. Smith, Article VII, in: Hobe, S., Schmidt-Tedd, B. and K. Schrogl (Eds), *Cologne Commentary on Space Law*, Vol. 1 Outer Space Treaty, Carl Heymanns Verlag, Cologne 2009, p.126-145.

¹⁰³ Such expansive definition of the term ‘to procure’ might have two opposite effects: first, it could lead States to refrain from making explicit requests (to order to avoid the risk of being regarded as launching States); second, if an emerging political dynamic would prompt many States to request or express support for the mission, it would significantly reduce the circle of innocent bystanders.

¹⁰⁴ Extrapolating this further, it may be discussed to what extent an international mandate requesting the carrying out a planetary defence mission would impact the notion of ‘third parties’ at large, particularly if such mandate was given based on an internationally recognised decision process or even as the result of international consensus.

with the occurrence of damage in the framework of a planetary defence mission. In this regard, processes or instruments may include:

- an **international mandate**, e.g. based on a binding UN Security Council decision; only this option would have the potential of embracing all or most States;
- an **international understanding (possibly in the form of an international agreement)** for the specific case of planetary defence measures triggered in case of a NEO emergency; depending on content, context and circumstances, such agreement could possibly be regarded as a *lex specialis*¹⁰⁵ norm to the Liability Convention;
- perhaps ad-hoc **waivers of liability** by those States not being launching States but potentially benefiting from or being affected by such mission; this may even lead to the discussion of a more general approach of being **exonerated from liability in return for undertaking a planetary defence mission** at own cost and for the benefit of others ('relief in return for action');
- **non-legally binding instruments**, although they would not suffice per se to override or alter legal obligations.

However, any such approach would have to be discussed bearing the very logic of 'third party liability' in mind, *i.e.* to protect those uninvolved States which suffer damage. The higher the probability of damage and the lower the predictability of where on Earth such damage may occur, the more imperative will it be to seek broad, inclusive solutions.

5.3.3. General aspects of reaching agreement

In general terms, anticipating the mitigation of liability risks is preferable over seeking solutions once damage has occurred. It might therefore be prudent to seek solutions, which may include the conclusion of legal instruments, regarding liability in connection with planetary defence missions *before* such missions are carried out, or while they are being prepared for.

Templates for such instruments could be developed before the discovery of an impacting NEO to have them available when a NEO threat situation arises. Broad agreement by the international

¹⁰⁵ That is, the agreement governing the specific subject matter (*lex specialis*) may override the legal instruments governing the general subject matter (*lex generalis*).

community may be advisable in view of the uncertainties with regard to the actual impact area as well as the possibility of damage on Earth due to a failure¹⁰⁶ of a planetary defence mission.

The legal basis for a particular mission could include waivers of liability in order to create incentives for States to conduct planetary defence missions. At the same time, it would also be advisable to include safeguards against negligent or intentionally destructive actions and to ensure compensation of victims on the ground as well as assistance by the international community to States that suffered damage. It is by achieving a clear and adequate balance of interests that the likelihood of later disputes can be reduced.

5.4. Conclusion

From the generic perspective of international law, a planetary defence mission is to be considered a space activity like any other, *a priori*: regardless of the mission's actual set-up and architecture, it will be linked in principle to one or more launching States. Should this mission result in damage to a third State, the launching States may be held liable to pay compensation to the victim State pursuant to international space law. This is true whether such damage occurs in outer space, on Earth or to aircraft in flight, and whether that damage is directly induced by the spacecraft or indirectly by an interaction between the spacecraft and the NEO, prompting the NEO to cause the damage.

However, the specific circumstances of a planetary defence mission raise specific legal questions that have been outlined in this chapter. Some of them cannot be answered with legal certainty today, as the answers depend on the factual circumstances as much as on their legal interpretation by those applying the law and, eventually, adjudging a case. However, in light of the possible consequences, it seems advantageous to seek legal risk mitigation through the securing of an appropriate understanding *before* an event occurs.

Legal liability represents a risk on the side of launching States as much as it secures protection on the side of the victim State. It may be mitigated by several methods including reaching agreement, through the establishment of appropriate legal instruments, among the circle of

¹⁰⁶ Two types of 'failure' have to be distinguished: the case where the attempted planetary defence mission failed to change the asteroid's trajectory (here, the space object did not cause damage, instead the natural events take their predicted course and consequently no launching State liability would be triggered); and the case where the planetary defence mission altered the asteroid's trajectory such that it caused damage on Earth that it previously, *i.e.* without intervention, wouldn't have done.

launching States on the one hand and between launching States and third parties on the other hand. Therefore, the broader and more inclusive such agreement is, the more will it ultimately reduce the risk on those States being potentially held liable, while safeguarding the interests or clarifying the consequences for those potentially suffering damage as 'bystander' States; broad international agreement would thereby inevitably reduce the number of such 'bystanders' through the inclusion of the latter in a framework of common understanding and action.

6. Considerations for Decision Bodies

6.1. Introduction

The distinctive scenario of a NEO impact threat presents a unique hazard to the international community and demands a decision process that provides the planetary defence effort framework with the necessary flexibility and resilience to produce an effective response to the wide range of scenarios and changing conditions that may arise. To this end the SMPAG Legal WG starts from the premise that a transparent, multilateral, and inclusive process that ensures international representation will be the most effective way to guarantee that planetary defence efforts are carried out in a reliable way which is widely acceptable. At the same time, it acknowledges the importance of avoiding a lengthy process that inhibits an effective response and of providing the flexibility and the resilience that is required.

There are a number of possibilities for decision-making bodies for the purpose of planetary defence both within the UN framework and outside. Within the UN framework are the United Nations Security Council, the United Nations General Assembly, and the United Nations Committee on the Peaceful Uses of Outer Space, as well as a possible ad-hoc decision-making group. An ad-hoc group could also exist outside of the UN. What should be kept in mind when it comes to choosing which one of these decision-making procedures to use, is that this choice is based on both legal and political considerations and will be made by political actors (which would be in the ambit of SMPAG Members to recommend to their Foreign Ministries and other appropriate political entities). Moreover, the choice will likely depend heavily on the facts and circumstances of the specific situation at the time. Each of the possible options has advantages and disadvantages depending on the specific NEO impact threat scenario that manifests and on political factors. In addition, these decision-making bodies are not mutually exclusive of one another. It may be possible to employ more than one of them simultaneously or sequentially. In the following subsections, some of the advantages and disadvantages of possible decision-making bodies will be analysed.

6.2. The United Nations Security Council

The United Nations Security Council (UNSC) has the authority to issue decisions, which are binding upon all UN Member States (Art. 25 UN Charter). These decisions prevail over any conflicting obligations under international law, including treaty obligations (see Art. 103 UN Charter). By taking the decision-making process under its authority, in the face of a NEO impact, the creation of a new entity or structure could be avoided. According to Article 28(1) of the UN Charter, each Member of the Security Council shall be represented at all times at the seat of the UN organization. Therefore, it can be convened quickly in a NEO threat emergency situation. The UNSC has the mandate to determine the existence of a threat to international peace and security, as well as to decide on measures to maintain or restore them, acting on behalf of Member States.¹⁰⁷ Under Article 39 of the UN Charter, the Security Council “*shall determine the existence of any threat to the peace...and...decide what measures shall be taken...*”. These measures may include military and non-military measures (Arts. 41 and 42 UN Charter).

The UNSC decisions would be binding upon Member States, as the Members of the United Nations “*agree to accept and carry out the decisions of the Security Council*” (Art. 25) and Members “*shall join in affording mutual assistance in carrying out the measures decided upon by the Security Council*” (Art. 49 UN Charter).

An authorisation by the UNSC of a planetary defence mission (especially when the mission is not in conformity with international law) would represent a multilateral approach that would give legal certainty to the State or States carrying out the mission. According to Article 103 of the UN Charter, in case of a conflict between the obligations of States under the UN Charter and their obligations contained in other international agreements, their obligations under the Charter prevail. So, if the UNSC determined that an Earth-approaching NEO constitutes a ‘threat to the peace,’ it could ‘decide’ that the use of a nuclear explosive device (NED) was the appropriate response. The Security Council could then authorize or order a designated country or countries to carry out the mission to deflect or destroy the NEO by using a NED.

As part of its decision, the Security Council could decide that the nuclear device could be used notwithstanding any inconsistency with the Outer Space Treaty, the Limited Nuclear Test Ban Treaty, or any other international agreement. The UNSC could further decide that the liability provisions of the 1967 Outer Space Treaty and the 1972 Liability Convention shall not apply to

¹⁰⁷ UN Charter Arts. 24.1 and 39.

the designated activity. In so doing, the UNSC would not amend or suspend these treaties, but its decision would supersede them in the specific case at hand.

A policy/political question is how the directly and indirectly affected States, just as the States carrying out the planetary defence mission, which may not be Members of the UNSC, could be involved in the decisions and process of authorization.

The UNSC consists of 15 Members, five of which are permanent (China, France, Russia, the United Kingdom, and the United States) and 10 are elected for a term of two years (Art. 23 UN Charter). The 10 non-permanent seats are traditionally allocated to the so-called 'Regional Groups' according to the following distribution:

- African Group: 3 seats
- Asia-Pacific Group: 2 seats
- Eastern European Group: 1 seat
- Latin American and Caribbean Group: 2 seats
- Western European and Others Group: 2 seats

Since an asteroid or comet impact might affect a large number of States, which may also change over time as predictions regarding the impact area on Earth evolve, the representation of States in the decision-making process is an important aspect. While the UNSC is not universally representative, Article 23 of the UN Charter and the Regional Groups could provide for representation of States. A potentially affected State could request its representative of the Regional Group to present its views and concerns. Yet, disagreements and diverging interests within regional groups might lead to situations where the views of affected States are not represented. In addition, the UNSC may invite a State to provide information about its particular views and concerns before a decision is taken. According to Article 31 of the UN Charter, any UN Member State, which is not a Member of the UNSC may participate, without a vote, in the discussion of any question brought before the UNSC, whenever the latter considers that the interests of that Member are specially affected.

The UNSC decides with a majority of 9 of 15 votes (Art. 27 UN Charter). On all non-procedural matters, the five permanent Members (the so-called Permanent Five or P5) have the right to veto. While international disagreements within the UNSC may be overcome by a majority vote, decisions could be rendered difficult by the possible use or threat of the veto by the five permanent Members of the UNSC.

6.3. The United Nations General Assembly

The United Nations General Assembly (UNGA) is formed by all the Member States of the United Nations. Its general function is to discuss any issues that are included within the scope of the UN Charter or relating to powers or functions of any UN organ (Art. 10 UN Charter). It is empowered to make recommendations to Member States to take measures for the peaceful adjustment of any situation, regardless of origin, which it deems likely to impair the general welfare or friendly relations among nations (Art. 14 UN Charter). Any such question on which action is necessary shall be referred to the Security Council by the General Assembly either before or after discussion (Art. 11 UN Charter). This characteristic of the UNGA is especially important in an impact scenario with significant warning time and especially in the early stages of the detection and trajectory assessment, when the probability or possible location of impact cannot be assessed with sufficient accuracy and could include a large number of States. Discussing such an impact scenario in the UNGA leads to the possibility that the international response gathers wider support because the UNGA involves not only the possibly-affected States but also those who have the capabilities and resources to support mitigation efforts. Additionally, those States that are not directly affected or that possess space capabilities can be involved. The broad involvement of the international community can lead to wide and long-lasting international support (though such an approach will likely not always be possible).

The UNGA meets on a regular basis, holding one regular session a year (starting always on the third Tuesday of September). It can be assembled for a special session at the request of the Security Council or of a majority of UN Member States (Art. 20 UN Charter). It has its own rules of procedure (Art. 21 UN Charter) and there are two ways of achieving a decision. On important questions, what is required is a two-thirds majority of the Members present and voting. For other procedures/questions, the majority of Members present and voting is required (Art. 18 UN Charter).

One of the main challenges regarding the General Assembly is that its decisions are not binding upon Member States. Another disadvantage will be that typically the UN General Assembly decision-making process takes time, so in NEO impact threat scenarios that have a small window of time to react, this option can lead to serious delays. In this case, the establishment in advance of an ad-hoc group framework could be an option that speeds up the process while maintaining legitimacy in an emergency situation - although creation of such a group could be in itself problematic.

6.4. The Committee on the Peaceful Uses of Outer Space

The Committee on the Peaceful Uses of Outer Space (COPUOS) is a specialized committee of the UNGA established to specifically address the peaceful uses of outer space. It has currently 92 Member States (as of January 2019), including all the major space-faring nations, and several international organizations and NGOs are permanent observers. An advantage of using COPUOS to advise the UNGA would be that it has specific expertise in the areas of space science, technology, law, and policy. The topic of Near-Earth Objects has been discussed in the Scientific and Technical Subcommittee of COPUOS as a regular agenda item, as well as in Expert Groups (Action Team 14 and Working Group on Near-Earth Objects).

Related to but separate from the UNGA and COPUOS, SMPAG and IAWN were established in 2014 through understandings of a subset of Member States and with endorsement by COPUOS and UNGA. These two UN-endorsed bodies represent important mechanisms at the international level for increased coordination in the area of planetary defence. IAWN and SMPAG regularly report to the Scientific and Technical Subcommittee of COPUOS. It would be important to take the information and recommendations of these two bodies into account during a decision-making process in a NEO impact threat situation.

A disadvantage of COPUOS could be that it generally decides by consensus, which could make decision-making difficult. Moreover, its decisions are not legally binding on member States. In addition, while the membership of COPUOS is constantly growing and includes the most important space-faring nations, it is nevertheless not universal. Yet, as in the case of the UNSC, regional groups could again be used to allow for the representation of non-Members.

6.5. Ad-hoc Group

One could think of a variety of solutions for a decision-making body specifically established for the purpose of planetary defence. Depending on the organisational structure of such a body this could have advantages and disadvantages. For instance, broad membership could on the one hand allow for representation of countries capable of conducting a planetary defence mission as well as countries potentially affected, but could on the other hand make decision-making lengthy and complex. More limited membership could have the advantage of enabling quick decision-making, but could mean that affected States may not be able to effectively influence

decisions. In general, it could be a time-consuming, personnel intense, costly, and politically difficult process to establish such a body.

One possibility to avoid this difficult process in a NEO impact threat emergency situation could be to agree on the modalities of the establishment, the organisational structure and the criteria for membership as well as the decision-making procedure of such an ad-hoc body in advance. If a framework that sets up these modalities is established in advance (e.g. by a UNGA resolution), the process could be facilitated at a time when quick decision-making is essential to avoid a NEO impact on Earth. The development of such procedures and modalities could be internationally representative to avoid challenges to the legitimacy of an ad-hoc group.

6.6. Conclusion

This chapter examined the value of coordination and cooperation among States from the moment that a potential impact threat has been identified and during the whole pre-event phase, noting the ongoing work of SMPAG and IAWN in this regard. During that period of time, the precision of the impact forecast will normally improve, and would necessitate appropriate measures at various scales (regional, national, and local). Live coordination could be needed among authorities, both at political and operational levels.

The SMPAG Legal WG suggests that SMPAG Members bring the question of coordination among States in the case of a NEO impact threat to the attention of States in order for them to investigate possible solutions, perhaps in the framework of the United Nations.

It is possible that relevant references may be found in concerns that are common in all threats or crises, such as pandemics, armed conflicts, natural disasters that involve more than one state territory, radiological emergencies, terrorist attacks, and displacement of people across borders, to name a few, while recognizing that each of these types of disasters may pose its own unique problems and opportunities.

At the international level, States work cooperatively to develop, agree upon, and then implement problem-solving plans appropriately. In this regard, the work of SMPAG and IAWN in the field of planetary defence is also relevant from a legal point of view. At a national level, based on its sovereign right, a State makes decisions and draws up its own measures for the protection of its territory, people, and assets. In a NEO impact scenario, governments could be required to differentiate tasks at an intergovernmental level and among research agencies (e.g.,

space agencies) and operational agencies (those dedicated to implementing contingency or natural disaster response programs) to facilitate the preparation process, since planetary defence involves many different disciplines.

Governments may need to coordinate their protocols and create response plans considering their geographical location, neighbourliness, population density, etc. Additionally, they could need to coordinate the necessary communication at the international, federal, state, and local levels in order to provide current and factual information to the population during the different stages of a potential impact scenario.

These activities are relevant to the international legal community as we seek to further develop international law with regard to planetary defence.

7. Summary

The following is a summary of the SMPAG Legal WG's analysis done to respond to questions and concerns that SMPAG Members have expressed regarding the potential legal implications of various planetary defence activities and options.

The following 'caveats' are to be considered:

- This work represents the views of the participating experts; it does not reflect the positions of national space agencies, ministries, or governments.
- This document contains preliminary interpretations; it is subject to revision following future developments. Many of the issues addressed in this report have not previously been addressed in depth by the legal community, and the discussions are based on little prior 'state practice' or legal evaluation; several of the points therefore remain tentative and debatable.
- This document is premised on the current facts and technologies of planetary defence; as those underpinnings change, the legal analysis and judgments may also be subject to revision.

The conclusions:

1. If a State has information relevant to the prediction of a NEO impact threat to Earth, such information should be made available in line with the Outer Space Treaty, in particular Article XI, which requires State parties to inform others about the results of space activities to the greatest extent feasible and practicable, as well as Article IX, according to which States shall conduct their activities in outer space with due regard to the corresponding interests of all other States Parties. In addition, elementary considerations of humanity require, in certain circumstances, the sharing of information in order to avoid the loss of human lives. This does require at least some degree of communication of data related to the discovery of NEOs.
2. If a significant NEO threat is known, the question arises whether a State has a legal obligation to undertake a mitigation action. A State has the right and the obligation to try to protect its own territory and population from catastrophic dangers. However, this obligation is to be assessed in consideration of the existing capacity and availability of resources of the State in question. There is no obligation under international law to assist

other States in any particular way or to any particular degree.

3. If any planetary defence-related information that is shared turns out to be incorrect, the SMPAG Legal WG concludes that there is no legal liability under international law in any of the following circumstances:
 - If a State (and this applies equally to SMPAG or IAWN) makes, in good faith, a diligent and well-founded probabilistic statement (such as giving notice that there is a certain likelihood of an asteroid impacting in a given location) there seems to be no international legal consequence associated to whether the event does or does not occur as forecast, even if the statement may have resulted in cost for those acting upon it; legal action under national law in domestic courts cannot be excluded, however.
 - If a State diligently releases objective information about a NEO threat, and that information is subsequently distorted or misinterpreted (e.g. by media), the State would not be responsible or liable for consequences caused by the distortion or misinterpretation.
 - If, however, a State in a grossly negligent manner or even deliberately releases information that it knows to be false, there might be a basis for a claim to compensation under general notions of state responsibility (for internationally wrongful acts).
4. A central question is what international law has to say about the choice among different types of planetary defence methods. The slow push/pull methods, which include gravity tractors, enhanced gravity tractors, ion beam shepherds and laser ablation, do not as such raise any particular issues of legality under international law unique to their character. However, in case of malfunctions, failures and damage caused on Earth or in outer space, the general rules on responsibility and liability apply. Impulsive methods, such as kinetic impactors and conventional explosives, are mainly of concern in circumstances similar to slow push/pull methods, except for the potential use of Nuclear Explosive Devices (NEDs) which raises additional legal issues. Furthermore, environmental considerations, including Article IX Outer Space Treaty as well as non-legally binding safety standards and principles, such as guidelines on space debris mitigation and the use of nuclear power sources in outer space, should also be taken into account when conducting planetary defence missions.

5. Regarding the use of NEDs in outer space, several treaties are relevant, as summarized below. The obligations contained in these treaties apply only to States that have become party to the relevant treaty; most (but not all) of the leading space-faring States have joined each instrument.
 - The Outer Space Treaty (Art. IV) bars three specific actions: placing a nuclear weapon in Earth orbit, installing it on a celestial body, and stationing it in space in any other manner. The SMPAG Legal WG concluded that the treaty is best understood as addressing the inherent nature or capability of a nuclear device, not simply its avowed purpose. The treaty makers intended to foreclose a nuclear arms race in space, and the inescapable dual functionality of a nuclear device would not change its nature and initial designation and does not allow to interpret a carve-out for planetary defence.
 - The 1963 Limited Test Ban Treaty (Art. I) requires its parties *“to prohibit, to prevent, and not to carry out any nuclear weapon test explosion, or any other nuclear explosion”* in the atmosphere, in outer space or under water. It also requires its parties *“to refrain from causing, encouraging, or in any way participating in”* such explosions. The Limited Test Ban Treaty therefore constitutes a very stringent prohibition against nuclear explosions in space. Unlike the Outer Space Treaty, the Limited Test Ban Treaty applies explicitly to ‘any’ nuclear explosion, regardless of purpose. The use of NEDs for the purpose of planetary defence is therefore prohibited under the Limited Test Ban Treaty.
 - The 1970 Nuclear Non-Proliferation Treaty prohibits all States Parties which are not recognized as nuclear-weapon States from acquiring or possessing NEDs or exercising control over NEDs and associated materials. It also prohibits the transfer of NEDs or of the control over NEDs by nuclear-weapon States Parties. It is the most important and nearly global treaty on nuclear non-proliferation. It would inhibit some possible forms of collaboration between States in the use of a nuclear device for a planetary defence mission.
6. States are obliged to act in accordance with their international legal obligations. Naturally, the same rules apply to space activities, including planetary defence missions, which must be carried out in accordance with international law. There are however exceptional instances where an action not in conformity with international law may not be regarded as wrongful. For example, this could be true in a case where the use of a nuclear device was determined to be the only method to avoid a catastrophic asteroid

impact. The applicable legal concept is ‘circumstances that preclude the wrongfulness’ of a State’s action that would ordinarily constitute an illegality. Such circumstances may be invoked only with utmost care. We considered three such exculpatory theories, each of which might be relevant in particular factual situations:

- Distress. The concept of distress justifies an otherwise illegal action undertaken by a state when there is ‘no other reasonable way’ to save human lives. Distress applies only to extraordinary situations and cannot be invoked if the conduct that is sought to be excused endangers more lives than it may save or is otherwise likely to create a greater peril.
 - Necessity. The concept of necessity applies when an otherwise illegal act is ‘the only way for the State to safeguard an essential interest against a grave and imminent peril’. Like distress, this principle is intended to be stringent, not allowing a State to escape too readily from its treaty commitments. Necessity might be applicable in some planetary defence scenarios, but only if the NEO impact threat is clearly and objectively established, if there is no other possible way of mitigating the impact, and if essential interests of other States are not seriously impaired.
 - Consent. Any State that requests or participates in a planetary defence operation that would ordinarily be regarded as unlawful has effectively waived its objection to the violation of its rights under international law, and the same may also be true of a State that merely supports the mission. Widespread endorsement for a planetary defence operation that used a nuclear explosive device, for example, would therefore carry legal significance. However, States that objected to the mission or that remained silent about it would not be precluded from complaining about the illegality.
7. If a planetary defence mission is undertaken by, or in collaboration with, non-state actors such as a private corporation or non-governmental organization, we conclude that this variation is consistent with international law. Under Outer Space Treaty Article VI, each State is internationally responsible for national space activities carried on by governmental agencies or non-governmental entities, and is required to authorize and continuously supervise non-governmental activities.
 8. Another concern is a State’s potential legal liability for a planetary defence mission, for example that diverted an incoming asteroid so that it impacted State X, instead of State

Y, where it would have struck if there had been no intervention or for other harms, caused for example by a malfunctioning space object.

The 1972 Liability Convention establishes an important distinction between causing harm to objects in space vs. causing harm on the surface of the Earth (or to aircraft in flight). In the former case, the launching State is liable only if it is at 'fault,' a concept not well defined in international law, but involving a wrongful act, acts of gross negligence or wilful misconduct. In the latter case, the State has 'absolute' liability, meaning that it is strictly obliged to compensate, even if it was not at fault. In other words, if a State undertakes a planetary defence action that results in damage to the territory of another State, the acting launching State is liable, even if it took all reasonable and appropriate measures to ensure the safe and effective actions of its launch vehicle and payload. In this case an important issue is causation. That is, the Liability Convention establishes liability for action 'caused by' a space object (*i.e.* a human-made spacecraft). The space object would be only indirectly the cause for damage inflicted on Earth, if the space object alters the trajectory of an asteroid, and it is the asteroid that directly damages the affected State. Ordinarily, this pattern of behaviour should be sufficient to trigger the liability of the launching State(s), but if the causal link became more tenuous – such as a case where there were other factors also affecting the asteroid's behaviour – the analysis could become more complicated. It could be useful to discuss questions of third party liability in advance of a planetary defence mission and seek broad international understanding, rather than being forced into a reactive approach once possible damage has occurred.

9. Regarding possible decision bodies for planetary defence action planning, under Chapter VII of the UN Charter, the Security Council has extraordinary power to deal with a 'threat to the peace'. It can authorize or require States to undertake action that would otherwise violate their obligations under other treaties (e.g. the use of a NED for planetary defence), and all UN Members have pledged to accept and carry out the decisions of the Security Council. In the event of a conflict between a State's obligations under the Charter and its obligations under any other treaty, the obligations under the Charter, including abiding by decisions of the Security Council, prevail.

Another possibility, in particular if the UNSC fails to act, due to a lack of the required majority among Members or due to a veto by one of the permanent Members, could be a recommendation by the UNGA. While the UNGA could allow a more representative and inclusive deliberation, its recommendations are not binding upon States and cannot overrule contradicting international law obligations.

Other international organizations, including UN bodies like COPUOS, could contribute to a broad political support for a planetary defence mission, but those institutions do not have authority to permit actions that are contrary to international law as the Security Council does.

10. The analysis shows that a number of international law rules are applicable to the conduct of planetary defence missions. Yet, some additional steps could be taken in the future in order to ensure that planetary defence missions are carried out in conformity with international law, to enhance legal certainty, diminish political concerns and increase international acceptance for proposed planetary defence measures. In the case of a NEO impact threat emergency situation, there will be limited time to make decisions and take action.

Therefore, a number of related documents for potential future planetary defence missions could be developed now, before an actual threat is detected, for instance by the SMPAG Ad-Hoc Working Group on Legal Issues. These documents could address important points that should be considered before action is taken to mitigate a NEO impact threat. The points considered could include elements of a mandate for States carrying out the planetary defence mission, a draft agreement by the potentially affected State(s) and the State(s) capable and willing to conduct the mission, modalities for the cooperation among States participating in the mission as well as common procedures to undertake the mission. They could moreover include liability considerations, such as a limitation or a waiver of liability for States conducting the mission, safeguards against negligent or intentionally destructive actions, and modalities for the compensation of victims on the ground or for other damage suffered as a result of the mission.

There is also a need for criteria and standards to be developed by technical experts and supported, where needed, by legal experts. These could encompass generally agreed criteria for the selection of planetary defence methods as well as parameters for the need of authorisation for certain planetary defence technologies, most importantly NEDs. In addition, safety standards for the conduct of planetary defence missions could be included.

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Note: the number of State Parties or Members is from October 2018.

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193 Members
- Statute of the International Court of Justice, Art. 38, opened for signature 26 June 1945, entered into force 24 October 1945, USTS 993.
<https://treaties.un.org/doc/source/docs/charter-all-lang.pdf>
193 Members
- European Convention for the Protection of Human Rights and Fundamental Freedoms, opened for signature 4 November 1950, entered into force 3 September 1953, 213 UNTS¹⁰⁹ 221.
<https://treaties.un.org/doc/Publication/UNTS/Volume%20213/v213.pdf>
Number of State Parties: 47
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<https://treaties.un.org/doc/Publication/UNTS/Volume 480/volume-480-I-6964-English.pdf>
Number of State Parties: 126
- International Covenant on Civil and Political Rights, opened for signature 16 December 1966 entered into force 23 March 1976, 999 UNTS 171.
<https://treaties.un.org/doc/Publication/UNTS/Volume%20999/v999.pdf>
Number of State Parties: 172
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¹⁰⁸ USTS: United States Treaty Series.

¹⁰⁹ UNTS: United Nations Treaty Series.

[English.pdf](#)

Number of State Parties: 105

- Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, opened for signature 22 April 1968, entered into force 3 December 1968, 672 UNTS 119, hereafter Rescue and Return Agreement.
www.unoosa.org/pdf/gares/ARES_22_2345E.pdf

Number of State Parties: 96

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[https://treaties.un.org/doc/Publication/UNTS/Volume 729/volume-729-I-10485-English.pdf](https://treaties.un.org/doc/Publication/UNTS/Volume%20729/volume-729-I-10485-English.pdf)

Number of State Parties: 191

- International Covenant on Civil and Political Rights, opened for signature 16 December 1966 entered into force 23 March 1976, 999 UNTS 171.
[https://treaties.un.org/doc/Publication/UNTS/Volume%201417/volume-1417-A-14668-English French.pdf](https://treaties.un.org/doc/Publication/UNTS/Volume%201417/volume-1417-A-14668-English%20French.pdf)

Number of State Parties: 172

- Vienna Convention on the Law of Treaties, opened for signature 23 May 1969, entered into force 27 January 1980, 1155 UNTS 331,
[https://treaties.un.org/doc/Publication/UNTS/Volume 1155/v1155.pdf](https://treaties.un.org/doc/Publication/UNTS/Volume%201155/v1155.pdf)

Number of State Parties: 116

- American Convention on Human Rights, opened for signature 22 November 1969, entered into force 18 July 1978, 1144 UNTS 123.
<https://treaties.un.org/doc/Publication/UNTS/Volume%201144/v1144.pdf>

Number of State Parties: 23

- Convention on International Liability for Damage Caused by Space Objects, opened for signature 29 March 1972, entered into force 1 September 1972, 961 UNTS 187 (Liability Convention).
[https://treaties.un.org/doc/Publication/UNTS/Volume 961/volume-961-I-13810-English.pdf](https://treaties.un.org/doc/Publication/UNTS/Volume%20961/volume-961-I-13810-English.pdf)

Number of State Parties: 95

- International Covenant on Economic, Social and Cultural Rights, opened for signature 19 December 1966, entered into force, 3 January 1976 993 UNTS 3.
<http://www.ohchr.org/Documents/ProfessionalInterest/cescr.pdf>

Number of State Parties: 169

- Convention on Registration of Objects Launched into Outer Space, opened for signature 14 January 1975, entered into force 15 September 1976, 1023 UNTS 15 (Registration Convention),
[https://treaties.un.org/doc/Publication/UNTS/Volume 1023/v1023.pdf](https://treaties.un.org/doc/Publication/UNTS/Volume%201023/v1023.pdf)
Number of State Parties: 64
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 - African Charter on Human and Peoples' Rights, opened for signature 27 June 1981, entered into force 21 October 1986, 1520 UNTS 217.
<https://treaties.un.org/doc/Publication/UNTS/Volume%201520/v1520.pdf>
Number of State Parties: 53
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9. Appendix

9.1. Summary of planetary defence methods for asteroids and comets

The aim of this appendix is to provide a comprehensive list of currently identified planetary defence methods for NEOs (Near Earth Objects, *i.e.* asteroids and comets), including their main challenges, and a rough estimate of their technical maturity at the present time.

For a measure of the technical maturity level, the NASA Technical Readiness Level (TRL)¹¹⁰ is used:

TRL 1	Basic principles observed and reported
TRL 2	Technology concept and/or application formulated
TRL 3	Analytical and experimental critical function and/or characteristic proof-of-concept
TRL 4	Component and/or breadboard validation in laboratory environment
TRL 5	Component and/or breadboard validation in relevant environment
TRL 6	System/subsystem model or prototype demonstration in a relevant environment (ground or space)
TRL 7	System prototype demonstration in a space environment
TRL 8	Actual system completed and 'flight qualified' through test and demonstration (ground or space)
TRL 9	Actual system 'flight proven' through successful mission operations

The choice of planetary defence method will depend on the size and orbit of the object, the amount of time before impact, and the technical maturity of the methods at the time of decision.

The list of methods has been split into 3 categories:

¹¹⁰ Mankins, J.C, *Technology Readiness Levels - A White Paper, Advanced Concepts Office, Office of Space Access and Technology, NASA, 1995.*

Impulsive methods

The impulsive methods are preferred at present, as they are powerful and fast acting, with the kinetic impactor being the technically simplest solution and the nuclear explosive method possibly being the only option in the worst-case scenarios.

Slow push/pull methods

The slow push/pull methods give much more control over the precise change in the object's orbit, and might become the preferred methods for small objects or small orbit changes in the coming years, when the technical maturity has increased.

Exotic methods

The exotic methods are ideas that could be exploited in the future though very little research has been done as of yet.

The following list was compiled based on inspiration from the following articles and reports: Eckersley and Brown (2013)¹¹¹, NASA's Report to Congress (2007)¹¹², Sanchez, et al. (2009)¹¹³.

9.1.1. Impulsive methods (TRL 5-7)

Kinetic Impactor

Method: A high velocity impact of a spacecraft into a NEO transfers momentum to it, thereby changing the orbit of the NEO. Ejected material from the impact can enhance the orbit change.

Main challenge: To impact a small target at high speed requires a very precise guidance, navigation and control system (GNC); effective against relatively small objects (<200 meters).

¹¹¹ Eckersley, S., C. Brown, NEOShield report: D7.5.1: Trade Offs of Viable Alternative Mitigation Concepts, 2013, www.neoshield.net/wp-content/uploads/2015/02/NEOShield_D7.5_Trade-Offs-of-Viable-Alternative-Mitigation-Concepts.pdf.

¹¹² NASA's Report to Congress, "NEO Survey and Deflection Analysis and Alternatives", March 2007. www.nasa.gov/pdf/171331main_NEO_report_march07.pdf.

¹¹³ Sanchez, J.P., C. Colombo, M. Vasile, G. Radice, 2009. Multicriteria Comparison Among Several Mitigation Strategies for Dangerous Near-Earth Objects, Journal of Guidance, Control, and Dynamics 32, 2009.

Nuclear Device

Method: A nuclear explosion close to a NEO or on/below its surface. The radiation vaporizes the surface material and ejects it at high speed. The pressure wave from an explosion on/below the surface can also cause large pieces of the NEO to fly off. With sufficient energy the NEO can be split completely into small pieces (some of which might however recombine).

Main challenge: Political opposition.

Conventional Explosives

Method: The pressure wave from a sub-surface chemical explosion causes NEO material to be ejected from the surface causing thrust.

Main challenge: Placing the explosive below the surface; achieving sufficiently powerful blast.

9.1.2. Slow push/pull methods (duration of the order of years, TRL 3-6)

Gravity tractor

Method: A spacecraft hovers close to a NEO using the gravitational attraction between it and the NEO to slowly modify the NEO's orbit.

Main challenge: Requires a massive spacecraft and long-term reliable operation close to a NEO.

Enhanced gravity tractor

Method: A spacecraft collects mass from the NEO to enhance its own gravitational field thereby speeding up the orbit change.

Main challenge: Successful collection of mass in addition to long-term reliable operation close to a NEO with the extra mass.

Ion beam shepherd

Method: A spacecraft beams ions onto the surface of a NEO (and also in the opposite direction to prevent it drifting off station). The ions hitting the surface at high speed create a small momentum change in the NEO.

Main challenge: Long-term reliable operation of an ion engine and GNC system.

Laser ablation

Method: A laser beam is aimed at the NEO. The energy creates flash vaporization of the surface. The ejected material provides a thrust on a NEO in the opposite direction.

Main challenge: The laser technology

9.1.3. More exotic concepts (TRL 1-2)

Spin-up and shatter

Method: Attach rockets at an angle to the surface of the asteroid to spin it up (i.e the Catherine-Wheel principle) beyond the rubble-pile rotation limit, causing the NEO to disintegrate.

Main challenges: Surface attachment; provision of rocket fuel; collision danger from ejected debris; not effective against a monolith NEO.

Thrust on the surface

Method: Place a spacecraft on the surface of the NEO and use the propulsion system to thrust outwards, thus pushing on the object. Due to its rotation the NEO needs to be spun-down first, or the thrust needs to be timed such that it is only active for a brief period once per rotation.

Main challenge: Surface attachment; rotation of the NEO.

Mass driver

Method: Land a spacecraft on the surface of the NEO, collect material from the surface and eject it at high speeds to create a thrust.

Main challenge: Collecting mass and ejecting it efficiently from a rotating NEO with little gravity.

Reflectivity change of the NEO

Method: Modify the reflectivity of the NEO's surface by changing its colour. A light surface causes a greater momentum reaction from reflected photons. A dark colour would change the thermal emission of the asteroid, causing more emission on the

afternoon side, which speeds up or slows down the NEO in its orbit, depending on its direction of spin (the Yarkovsky effect). The Yarkovsky effect is expected to be the dominant effect.^{114 115}

Main challenges: Technical complications of colouring the surface; deflection effect is very weak.

Conductive coating

Method: Apply a conductive coating to the surface to alter the orbit via interaction with the interplanetary magnetic field or by using an 'electrostatic tractor' spacecraft.

Main challenge: Technical complications of covering the surface.

Solar Shadow

Method: Deploy a sunshade large enough to partially or fully shadow the NEO, in order to change the solar radiation pressure or the Yarkovsky effect.

Main challenges: Deployment of a sunshade large enough; deflection effect is very weak.

Focused solar light

Method: Focus solar light via mirrors onto a point on the NEO surface creating flash vaporization of the surface. The ejected material imparts an impulse on the NEO in the opposite direction.

Main challenges: The large mirror structure; contamination from the surface material.

Microwave energy

Method: Direct microwave energy into the surface of the NEO to evaporate the water within the surface material causing small explosions, which act as thrusters. The method would be applicable only to those asteroid types with significant water content.

Main challenges: Sufficiently powerful microwave emitter; directing the microwave energy; not effective against a wide range of NEO compositions.

¹¹⁴ Vokrouhlický, D., A. Milani, 2000. Direct solar radiation pressure on the orbits of small near-Earth asteroids: observable effects? *Astronomy and Astrophysics*, 362, 746-755.

¹¹⁵ Hyland, D.C., H.A. Altwaijry, S. Ge, R. Margulieux, J. Doyle, J. Sandberg, B. Young, X. Bai, J. Lopez, N. Satak, 2010. A Permanently-Acting NEA Mitigation Technique via the Yarkovsky Effect. *Journal of Cosmic Research* 48, 430-436,

Increase comet activity

Method: Provoke enhanced cometary activity at a specific location to create an ejection of surface mass in a single event or multiple events.

Main challenge: Control of the direction of ejecta.

Mechanical resonator

Method: Land a mechanical resonator on the NEO to create vibrational pulses at the NEO's natural frequency causing it to break apart.

Main challenge: Adequate surface attachment to efficiently transfer the vibration to the NEO.

9.2. Planetary Defence Scenario Case Study 2017

To illustrate how an impact-threat situation could develop, the following appendix describes a hypothetical scenario in which an asteroid is discovered to be on course to impact the Earth and countries worldwide have to decide how to respond. It will also address the legal implications of those choices.

The threat situation is taken from a tabletop exercise held during the 2017 International Academy of Astronautics (IAA) Planetary Defense Conference in Tokyo.¹¹⁶ Around 200 international scientists, technical experts, decision makers in space agencies and emergency response people participated but the legal implications were not explicitly addressed. A ‘world leaders’ group was charged with making decisions and authorizing actions to be taken based on the advice from various groups representing the scientific/technical, emergency response, and other communities.

The threat scenario spanned a 10-year period, with T-10 years meaning 10 years before the possible impact time. Each of the first 4 days of the 5-day conference ended with ‘press releases’ of the latest information about the threat and the outcome of previous decisions, followed by discussions within the groups and new decisions by the World Leaders. The appendix is structured such that each subchapter will explain the threat scenario at that time, and choices the ‘World Leaders’ had, as well as any legal questions that might have arisen. We will then try to answer those questions on the basis of the report.

9.2.1. T -10 years (May 15, 2017)

First simulated press release: The exercise started with a simulated press release stated that a roughly 100-250 meters asteroid had been discovered that would fly close by the Earth on July 21st 2027. The limited observations of the asteroid meant that its orbit was still very uncertain, and there was a 1 in 100 chance of the asteroid impacting Earth on that date. The possible impact region on the Earth, or ‘impact corridor’, shown by red dots in Figure 1, covers the Pacific Ocean, Japan, China, Kazakhstan, Russia, northern Europe, and the British Isles. The exercise participants were asked to decide what action should be taken.

¹¹⁶ <http://iaaweb.org/iaa/Scientific Activity/report2017pdc.pdf>

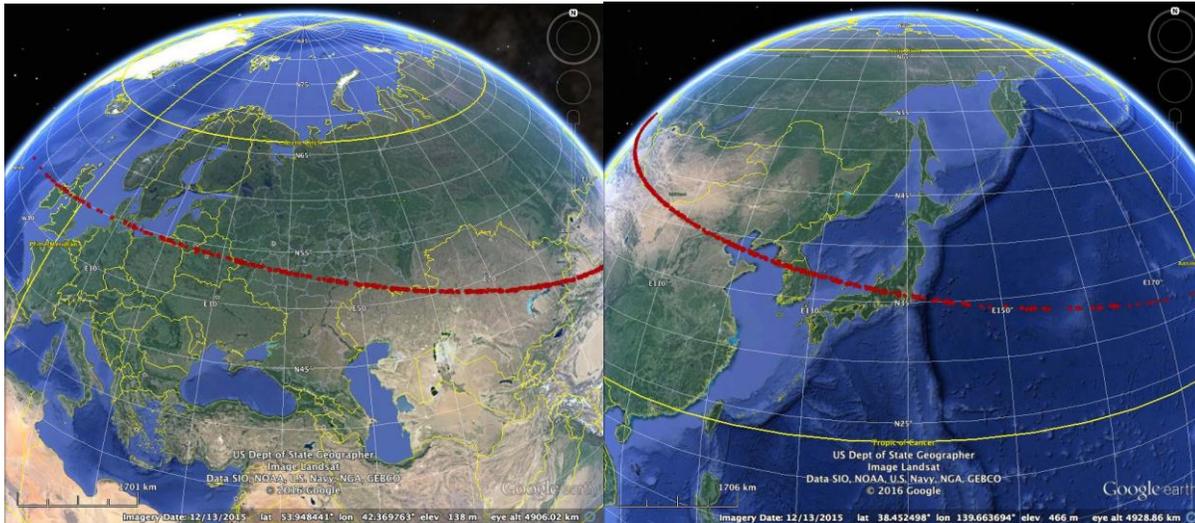


Figure 1: First press release on the hypothetical asteroid expected impact region on Earth, called the impact corridor. As there can be large uncertainties in the orbital parameters used in the calculations of where it will impact, you get a large number of possible impact points, when varying the parameters within the uncertainties. Each red dots represent a calculated impact point and how close the dots are, indicate the possibility of impact in that area. Impacts can therefore occur between the red dots. (Image credit: the PDC 2017 tabletop exercise and Google Earth).

After much discussion and presentations by the different interest groups, it was decided by the 'World Leaders' that:

1. The telescopic observational capabilities needed should be made available to obtain more information on the asteroid while it is still observable from Earth (rest of 2017).
2. Two fast flyby missions of the asteroid should be developed quickly by cannibalizing planned space missions for instruments/launchers, with the objectives of measuring the shape of the asteroid and determining its orbit more precisely.
3. Planning should also start for a later, larger rendezvous mission, which would take longer to arrive but would end up orbiting the asteroid. It would investigate the asteroid in greater detail and the resulting data would allow the outcome of possible deflection missions to be estimated.

It was suggested that the rendezvous mission could deliver a Nuclear Explosive Device (NED) for deflection purposes, and that policies for using NEDs for planetary defence should be quickly drafted and enacted (see the chapter on [Legality of Planetary Defence Methods](#)). Other deflection missions should also be investigated.

9.2.2. T -9 years, 30th of November 2018

Second simulated press release: The orbit uncertainty is now smaller and the impact probability has risen to 96%. Due to the orbital parameters being now better measured, the uncertainties are reduced and the shrunken impact corridor now passes only through China, North and South Korea, Japan and the Pacific Ocean and includes the high population density areas of Beijing, Seoul and Tokyo (see Figure 2). The new observations have shown that the asteroid is expected to be 200-280 m wide (possibly larger than the previous estimates) with the ability to create a blast with a radius of 50-250 km at impact. An impact in the Pacific would cause a tsunami, which could affect many countries but would result in less damage and risk than a land hit.

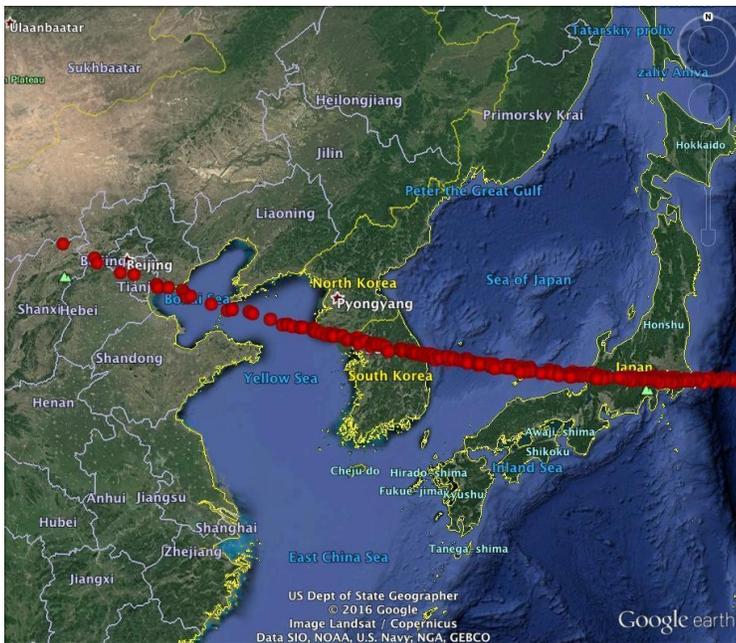


Figure 2: Shows the possible impact area of the hypothetical impact threat after the second press release. (Image credit: the PDC 2017 tabletop exercise and Google Earth).

Legal scenario question on decision-making, part 1:

Who should participate in a decision making body - the countries in the impact corridor, the countries possibly affected by a tsunami, the part of the rest of the world whose economy might also be affected? How should the rest of the stakeholders deal with international disagreements or States, which refuse to work together or are in armed conflict?

Legal scenario answer:

A number of possibilities exist for decision-making bodies for the purpose of planetary defence. The choice about which one of these decision-making bodies to use is more political than legal. However, there are legal aspects, which should be considered and which will be analysed in the following. Moreover, when that choice is made, it will depend on the facts and circumstances of the specific situation at the time. In addition, it may be possible to employ more than one of the possible decision-making bodies simultaneously or sequentially.

One could think of a variety of solutions for a decision-making body specifically established for the purpose of planetary defence. Depending on the organisational structure of such a body, the respective advantages and disadvantages should be considered. For instance, broad membership could, on the one hand, allow for representation of countries capable of conducting a planetary defence mission as well as countries potentially affected but could, on the other hand, make decision-making lengthy and complex. More limited membership could have the advantage of enabling quick decision-making but could mean that affected States may not be able to influence decisions. In general, it could be a time-consuming, cost-intensive and politically difficult process to establish such a body. Therefore, a more practicable solution could be to use existing structures within the UN system.

Available and potentially relevant organs are the UN General Assembly (UNGA), with its sub-organ the UN Committee on the Peaceful Uses of Outer Space (COPUOS), or the UN Security Council (UNSC). The UNGA has the advantage of being the most representative of the UN organs, as all UN Member States are represented and have a vote. However, its decisions are not legally binding upon its Members and have therefore only the character of recommendations or political declarations.

COPUOS is a specialized sub-organ of the UNGA specifically dealing with the peaceful uses of outer space. It has currently 92 States as Members, including all the major space faring nations, and several international organizations and NGOs as permanent observers. However, it usually decides by consensus, and its decisions are not legally binding.

By contrast, decisions of the UNSC are legally binding upon all UN Member States. This follows from Article 25 of the UN Charter according to which Member States have agreed “to accept and carry out the decisions of the Security Council in accordance with the Charter”. According to Article 24 of the UN Charter the UNSC has the “primary responsibility for the maintenance of international peace and security”.

In addition, the UNSC has the power to take decisions which overrule contradicting obligations under international law. According to Article 103 of the UN Charter, in the event of a conflict between the obligations of the UN Members under the UN Charter and their obligations “under any other international agreement, their obligations under the present Charter shall prevail”.

The UNSC consists of 15 Members, 5 of which are permanent (China, France, Russia, United Kingdom, United States) and 10 are elected for a term of two years (Art. 23 UN Charter). The 10 non-permanent seats are traditionally allocated to the so-called ‘Regional Groups’, including the African Group, the Asia-Pacific Group, the Eastern European Group, the Latin American and Caribbean Group, and the Western European and Others Group.

The UNSC decides with a majority of 9 of 15 votes (Art. 27 UN Charter). On all not merely procedural matters, the 5 permanent Members have the right to veto. As an asteroid impact might affect a large number of States, which may also change over time as predictions regarding the impact area on Earth evolve, the representation of States in the decision-making process is an important aspect. While in the UNSC not all States are always represented, the non-permanent Members and the Regional Groups could provide for representation of States. A potentially affected State could instruct its representative of the Regional Group to present its views and concerns. Yet, disagreements and diverging interests within regional groups might lead to situations where the views of affected States are not represented.

In addition, the UNSC may invite a State to provide information about its particular views and concerns before a decision is taken. According to Article 31 of the UN Charter, any UN Member, which is not a Member of the UNSC may participate, without a vote, in the discussion of any question brought before the UNSC, whenever the latter considers that the interests of that Member are specially affected.

It follows that in the situation of a NEO impact threat, the countries in the impact corridor, countries possibly affected by a resulting tsunami, countries whose economy might also be affected, and the rest of the stakeholders, as long as they are States, may be invited to participate in the discussion of the UNSC relating to a planetary defence mission.

If a policy on planetary defence is to be developed, the possibilities contained in Article 31 of the UN Charter could be formulated as a specific recommendation for the UNSC. This could ensure that the rights of affected countries are duly taken into consideration.

International disagreements within the UNSC may be overcome by a majority vote. Political differences between some States may influence the decision making process in the UNSC.

However, as mentioned above, a majority vote is possible and sufficient. Yet, decisions of the UNSC could be rendered difficult by the possible use or threat of the veto by the 5 permanent Members of the UNSC.

In the Scenario the SMPAG coordinated the international response and a fast flyby characterization mission was prepared for launch in October 2019 with a flyby of the asteroid in May 2020.

The deflection mission could be chosen to either speed the asteroid up or slow it down, pushing the impact point eastward across the Koreas and Japan to the Pacific Ocean or westward across Asia and Europe, respectively.

The deflection mission possibilities were:

- 2 rendezvous missions including NEDs, to observe the asteroid in detail and deflect it. Only 1 mission needs to be successful. However, due to the necessity of rapid development and testing of the spacecraft, the mission failure rate is expected to be 50%. The price would be around \$3 billion.
- Westward, requiring a minimum of 3-4 (6-8 for redundancy) kinetic impactors and the missions could be launched as late as 5 years from the present. Price around \$10 billion with two non-NED rendezvous missions.
- Eastward, crossing fewer countries and requiring a minimum of 3 (6-8 for redundancy) kinetic impactors launched within just 16 months from the present, with a commensurately larger risk. They would impact the asteroid in February 2024. The cost would also be around \$10 billion.

Legal scenario question on the nuclear device method, part 1:

Should a NED be launched with the rendezvous mission? It would be \$7 billion cheaper than sending 6-8 kinetic impactors. It would, however, not be 'a last resort'. It was also suggested to send it along but only use it if the kinetic impactors failed. Then it would be the last resort.

Legal scenario answer:

The decision whether the rendezvous spacecraft should carry NEDs has technical and legal aspects. As regards the technical aspects, the risks of the launch and of a malfunctioning of the NEDs must be thoroughly considered. They include danger to human life and property and to the environment of the Earth and outer space during and after the launch. This assessment is important regardless of any obligation of any State involved to compensate for the damage.

As regards the legal aspects, the explosion of a NED in outer space would be contrary to the Limited Test-ban Treaty of 1963 which prohibits all nuclear explosions in outer space. The NED mission planning and launching as such could also contradict the Non-Proliferation Treaty of 1968 whose objective is to prevent the spread of nuclear weapons and weapons technology. Article 1 of the Non-Proliferation Treaty prohibits “to transfer to any recipient whatsoever nuclear weapons or other nuclear explosive devices or control over such weapons or explosive devices directly, or indirectly”. Therefore, as regards international cooperation in that endeavour, care must be taken that nuclear weapons technology is not transferred to non-nuclear-weapon States. Moreover, Article IV Outer Space Treaty would be violated which prohibits placing a nuclear weapon in orbit, installing it on a celestial body, and stationing it in space in any other manner.

If the UNSC is called upon to take the decision on the mission, contradicting treaty obligations regarding nuclear explosions are not an obstacle to the legality of the use of a NED. As mentioned above, Article 103 of the UN Charter makes clear that the obligations under the UN Charter—which includes binding decisions taken by the UNSC – prevail over conflicting obligations under any other international agreement. Another possibility, in particular if the UNSC fails to act, could be a recommendation by the UNGA. While the UNGA could allow a more representative and inclusive deliberation, its recommendations are not binding upon States and cannot overrule contradicting international law obligations.

Whether the NED is a ‘last resort’ only plays a role when the multilateral decision making process in the UNSC is politically not possible and the UNSC does not take a decision. Then any State or group of States could only rely on the circumstances precluding wrongfulness, defined in the International Law Commission (ILC) Articles on State Responsibility, in particular the ‘state of necessity’ which precludes the wrongfulness of an act of a State which otherwise would be unlawful. This option could, however, bear more uncertainty as it is a unilateral approach. The conditions for the invocation of ‘necessity’ are very strict. According to Article 25 of the ILC Articles on State Responsibility, necessity can only be invoked, if the act (a) is the only way for the State to safeguard an essential interest against a grave and imminent peril; and (b) does not seriously impair an essential interest of the State(s) towards which the obligation exists, or of the international community as a whole. It will therefore be necessary to argue that the explosion of a NED for the purpose of planetary defence is the only way to safeguard the potentially affected States from the impact. In addition, it must be ensured that the deflection of the asteroid does not lead to an impact on other States and that no other serious dangers are caused to the international community as a whole, such as harm to the Earth or to the Earth and outer space environment through radioactive contamination or space debris.

Legal scenario question on the choice of who to endanger:

If less than 3-4 kinetic impactors were to succeed then the asteroid would still impact the Earth, but possibly in a country other than one in the original impact corridor. How should one choose in which direction to move the impact point and therefore which countries are exposed to the impact risk?

Legal scenario answer:

To shift the risk from one group of countries to another group of countries is extremely problematic. The legal parameters remain the same as discussed above. It is therefore a political question whether and where the impact point should be shifted. This decision is politically very problematic in part because the legal rights are directly in conflict. Under international law each State has an equal right not to be harmed. Such a decision could therefore primarily be based on a common technical assessment of the chances and risks of success of the chosen planetary defence method. Whether and to what extent there will be responsibility and liability for damage will be discussed under the questions below.

The decisions made by the World Leaders were that we should at all cost avoid a hit in heavily populated areas. Two rendezvous missions with NEDs would be sent, but would only be used if the kinetic impactors failed and the NEDs were a last resort. 8 kinetic impactors would be sent to make an eastward push, due to the fewer countries at risk during the deflection campaign. If the building of the spacecraft is not completed in time, then they should all be sent at the later westward launch date. Different countries would build 1-3 kinetic impactors each, with different designs to maximize redundancy.

9.2.3. T -7 years (May 15, 2020)

Third simulated **press release:** The 2 flyby missions commissioned after the first press release flew past the asteroid and observed it. The improved orbit uncertainty limits the impact corridor to include only Tokyo (see Figure 3). Close-up images of the asteroid have revealed that it is 270 m in diameter and has a moon of 100-meter diameter.

Only 6 of the 8 kinetic impactors were completed on time for the eastwards launch deadline and it was decided to launch them anyway and abandon the westward possibility (pushing the asteroid eastward would preclude a later westward possibility). One of the kinetic impactor missions failed during launch, so only 5 were sent towards the asteroid. The new observations showed that the asteroid is 20% more massive than expected and that all 5 kinetic impactor

missions will have to succeed to divert the primary asteroid off the Earth. There is however a chance that the deflection attempt on the primary asteroid could dislodge the moon and leave it continuing on an impact trajectory. On the other hand, only two successful kinetic impacts would move the asteroid impact point 800 km away from the coast into the Pacific, where a tsunami would only result in minor damage.

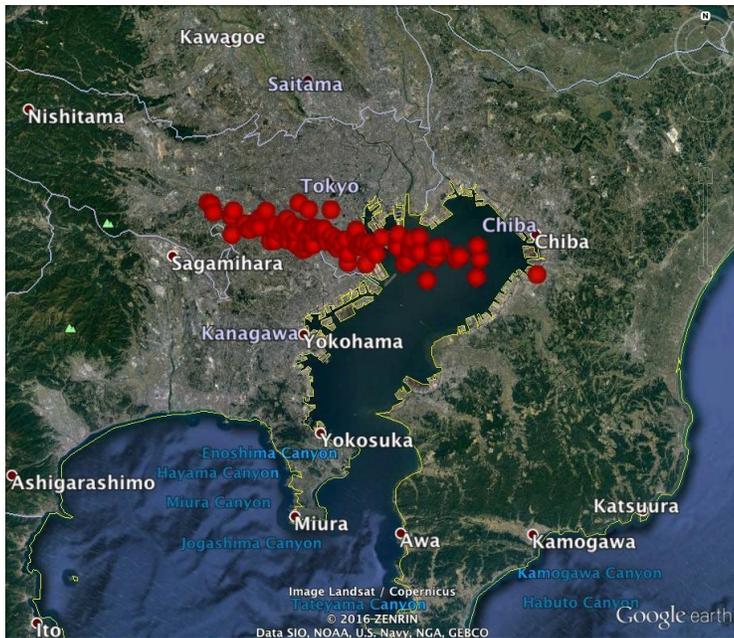


Figure 3: Impact corridor over Tokyo of the hypothetical asteroid impact threat. (Image credit: the PDC 2017 tabletop exercise and Google Earth).

Legal scenario question on liability:

Would the States involved in the deflection action be held responsible for damage if their kinetic impactors failed or weren't ready on time, with the result that the asteroid impacted, possibly in a State not originally in the risk corridor? How could the compensation of victims be envisaged?

Legal scenario answer:

The States involved in the deflection action will in principle be subject to the rules on responsibility and liability as provided in the Outer Space Treaty and the Liability Convention. According to Article II of the Liability Convention, the launching State is absolutely liable for damage caused on Earth by a space object launched by it. An asteroid cannot be regarded as a 'space object', because it is neither 'launched' from Earth nor is it a man-made object. However, a damage caused by an asteroid impact to a State not originally situated in the risk corridor after being targeted by a deflection mission could nevertheless be regarded as 'caused' by a space object. This would entail the liability of the State(s) carrying out the planetary defence mission. If the mission was not able

to impact the targeted NEO at all or was not ready on time and therefore did not 'cause' any damage on Earth, States involved in the mission would not be liable.

In addition, States are 'responsible' for their activities in outer space even when no damage was caused by a space object (Art. VI Outer Space Treaty). The development and launch of conventional kinetic impactors – as opposed to NEDs – is not prohibited under international law. Only their use as 'weapons' against the territorial integrity and independence of another country would be prohibited as a 'use of force' under international law (Art. 2(4) of the UN Charter). This is certainly not the case if a kinetic impactor is launched with the purpose to save one or more States from the impact of an asteroid.

The question remains whether the mere malfunction of a kinetic impactor – which may or may not be due to negligence – raises the issue of responsibility. Responsibility only becomes engaged under international law, if a State has acted unlawfully. This is the case when binding international norms have been violated. The norms under international law with regard to the required knowhow to conduct space missions are not sufficiently detailed to determine responsibility for failed missions. A malfunction, even when it may be due to negligence, therefore does not engage the respective State's responsibility.

Reference may, however, be made to Article IX of the Outer Space Treaty which requires that States shall conduct all their activities in outer space with 'due regard to the corresponding interests' of all other State Parties to the Treaty. While this provision is relatively vague, it could provide a basis for the argument that States and other entities with sufficient knowhow should carry out space activities and that state of the art technology should be used. In order to remove any remaining doubt whether the obligation of 'due regard' of the interests of other countries has been taken into consideration, a decision taken by the UNSC could be a possibility. Such a decision could clearly define which States and actors should undertake the planetary defence mission and with which methods. In this case, any responsibility of a State authorized to be involved in the deflection action would be ruled out. In addition, such a decision could also include possibilities for exoneration from liability for damage caused in the course of planetary defence efforts as well as safeguards against grossly negligent or intentionally destructive actions.

Victims of the impact of an asteroid which has been targeted by a deflection mission can be regarded as victims of the activity of the States participating in the mission. This is true in the case of the use of kinetic impactors and other methods. For the use of NEDs specific rules apply in addition.

It follows that there may be liability or responsibility of States involved in a deflection mission. In order to share the financial burden, international and national mechanisms could be established to compensate the victims.

Legal scenario question on decision-making, part 2:

Due to his country's history, the representative of Japan (the targeted country) was very opposed to the use of NEDs, while many other groups were in favor. How much decision-making influence would the impacted country have in such a situation? If the targeted country decided not to take any actions and/or to refuse the use of NEDs due to cultural/religious beliefs, could other countries intervene anyway?

Legal scenario answer:

As discussed above, one possibility in this situation could be the authorisation of a mission involving the use of NEDs by the UNSC. The UNSC may involve the affected State in the discussion, but the State does not have a vote, unless it is itself a permanent or, as in this case, non-permanent Member (Art. 31 of the UN Charter). The affected States could, however, try to convince the Members of the UNSC, in this case in particular those representing the Asia-Pacific Group, to decide in accordance with its view. A decision of the UNSC needs 9 out of 15 votes. If Japan succeeds to convince one of the permanent 5 countries to exercise its veto right, this would also be sufficient to block the decision.

Legal scenario question on decision-making, part 3:

It was also simulated that one of the Members of the UNSC followed Japan's decision and vetoed the use of NEDs. The remaining World Leaders decided to ignore the veto from the UNSC and planned an inter-agency collaboration to send NEDs on their own. Did they break International Law by not following the UNSC's veto nor the targeted country's wishes?

Legal scenario answer:

If the UNSC does not authorize a mission involving NEDs, the use of NEDs would violate the obligations mentioned above. If the UNSC takes a decision which obliges States to use another planetary defence method, to ignore this decision and to act in its contravention would constitute a violation of international law. This would make the entire mission unlawful and entail the responsibility of all States involved in the planetary defence mission. The targeted country's wishes themselves do not add to the unlawfulness of the activity, as mentioned above.

The World Leaders decided that it wasn't only up to Japan, as the economy of the entire world experienced a serious downturn due to the threat of a major disaster. It was decided to carry NEDs on the rendezvous missions and on 2 additional flyby missions to be sent later.

9.2.4. T -4 years (June 15, 2023)

Fourth simulated press release: One of the rendezvous spacecrafts reached the asteroid a month before the press release (the other failed during flight) and has now 8 months to wait before the kinetic impactors arrive.

Legal scenario question on the nuclear device method, part 2:

Should we wait for the kinetic impactors to arrive and impact, with the chance that the waiting rendezvous spacecraft fails in the meantime, or detonate the NED as soon as possible and treat the kinetic impactors as backup?

Some World Leaders protested to the idea of sending NEDs that might stay undetonated in space. For that reason, the idea of installing a 'kill-switch' on the NEDs emerged. In terms of International Law, which would be the preferred option: a non-detonated NED or an unused NED detonated via a kill switch?

Legal scenario answer:

The question whether a non-detonated NED or an unused NED detonated via a kill switch is preferred under international law also has technical and legal aspects. In addition to the prohibitions mentioned above, the detonation of a NED could also cause a lot of fragments and radiation in outer space. It depends on the position of the detonation in outer space whether this creation is dangerous to other space activities and therefore contrary to the requirement of avoidance of 'harmful contamination' and due regard to the 'corresponding interests of other countries' according to Article IX of the Outer Space Treaty.

A non-detonated NED in outer space in all likelihood has less harmful consequences for the outer space environment and is therefore less likely to violate Article IX of the Outer Space Treaty. It would also not violate the Limited Test-Ban Treaty which prohibits nuclear explosions in outer space. However, the acquisition of weapon-related information by non-nuclear-weapon States through their participation in activities related to the non-detonated NED would be prohibited under the Non-Proliferation Treaty. In addition, a non-detonated NED stationed in outer space would violate Article IV of the Outer Space Treaty. Thus, the explosion as well as the stationing

of NEDs in outer space would violate obligations under international law and would entail the international responsibility of the States involved.

Again, a possible option in this situation could be an authorization of the use of NEDs by the UNSC which has the power to overrule contradicting obligations under international law. Another possibility, if the UNSC fails to act, consists in the possible invocation of circumstances precluding wrongfulness, and in particular the plea of necessity. As the scenario is described, the explosion of the NEDs would in this case not be the only way to deflect the NEO, so that the plea of necessity would fail.

In the Scenario the World Leaders decided to detonate the NED and leave the kinetic impactors as backup, due to the greater chance of success and the worsening downturn in the world economy. The explosion neutralized the impact threat.

9.2.5. Conclusion

This case study shows how a NEO impact threat scenario could evolve and which planetary defence options may be available at different times. It also illustrates several of the legal issues that could potentially arise during a NEO impact threat situation. These include for instance legal aspects of the use of NEDs in outer space, liability for damage caused during a planetary defence mission as well as international decision-making processes. What becomes clear from the scenario is that many of the decisions which may be taken in the context of a planetary defence operation are political rather than legal. Legal factors frame the choices, but the ultimate decisions are taken by political actors. In the case of a NEO impact threat emergency situation, there might be limited time to take decisions. Thus, the more awareness exists among political actors and the international community about the possibility of a NEO impact threat as well as about the legal questions involved, the better can it be assured that planetary defence efforts can swiftly be carried out in accordance with international law.