

Outer Space: Ungoverned or Lacking Effective Governance?

New Approaches to Managing Human Activities in Space¹

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All spacefaring nations, as well as many other nations, have ratified the Outer Space Treaty, a document that outlines a number of principles for human activity in space. These principles include the use of space for peaceful purposes, the freedom for all nations to access space, the goal of using space for the benefit of all peoples, and no nation may declare sovereignty in space. Associated with these principles are concepts that have popularized the idea that space is a global commons. Examples in history of terrestrial commons do not provide an adequate framework for the future handling of space resources, space exploration, nor for resolving the competing public and private interests of using outer space. There are many voids in space law, and methods to effectively govern different aspects of space activities are not directly addressed in most national and international regulations. Nations, such as the United States, which have very advanced technological capabilities are expanding efforts to encourage private enterprise in outer space through new legislative incentives. These incentives have created both support and controversy in many forums as they expand and stretch some traditional interpretations of the space treaties. This paper will explore pragmatic ways the outer space environment can be effectively managed to avoid misuse, overuse, or abuse, while recognizing the future economic inevitability of nongovernmental space activities.

Introduction

The space domain is currently undergoing a period of significant change. Part of this change includes certain activities that were long considered science fiction becoming feasible. These activities include: fixing broken satellites in space, deflecting asteroids to avoid hitting the Earth, using water found in space for fuel and other purposes, and mining valuable mineral resources.

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Another major change is the rapid rise of for-profit companies in space launches, operations in orbit, and planning new uses of space. Since the advent of the space age in the 1960s, almost all space activities were managed and performed by governments or by industries operating under strict governmental controls and supervision.

Four space treaties were negotiated through the United Nations Committee on Peaceful Uses of Outer Space (UNCOPUOS) during the 1960s and early 1970s.⁵ The first treaty drafted, commonly known as the Outer Space Treaty (OST), serves as the “master document.” This treaty establishes the principles and laws for many of the subsequent, more specific treaties. The OST has been ratified or signed by 129 nations, including all that are spacefaring.⁶

It is important to recognize that these treaties: 1) focus on human exploration and use of space, not on outer space itself, 2) obligate states to a set of responsible behavioral principles, 3) do not address private sector activities or responsibilities except to link non-governmental activities to an “appropriate” state to authorize and supervise those activities, and 4) emphasize the peaceful use of space and encourage international cooperation.

A fifth treaty, the Moon Agreement, finalized in 1979 and entered into force in 1984, has only been ratified by 16 nations.⁷ Essentially, it is a failed treaty because its provisions bind only those very few nations and the largest spacefaring nations, the United States, Russia, and China, are not party to it.

The treaties do not imply or advocate any form of formal governance of space.⁸ They are not self-executing and thus require nations that have ratified them to pass legislation to fulfill their treaty obligations. National interpretations of various treaty provisions may vary considerably. There is no special court system or means of enforcing the provisions of these space treaties. Courts such as the International Court of Justice can be used to settle such disputes among states. (Only states can bring actions to such courts; private entities cannot directly bring actions, although national court systems offer other possible courses of action for a private entity.) The treaties focus on diplomatic negotiations to solve international issues in space.⁹

Is Space a Global Commons?

Following the general ideals of the space treaties, many diplomats, lawyers, and government officials have often referred to outer space as a global commons. This means that space is a place where no state can declare sovereignty,¹⁰ and

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where, akin to the high seas, freedom of access and passage as well as the exploration and use of resources by all is open to all nations and peoples.¹¹

The space treaties include several different phrases defining the exploration and use of outer space.

These include: “...for the benefit of all peoples (countries),” and “...shall be the province of all mankind.” The Moon Agreement extends these ideas, where “the Moon and its resources are the common heritage of all mankind.”

It is also important to note that the noun, *commons*, never appears in any space treaty. Furthermore, *common*, is used in the treaties only twice as an adjective, a descriptor, in the following way: common interest and common heritage.¹² The phrases common procedures and common understanding, also appear in UN General Assembly Resolutions dealing with outer space issues.¹³

None of the usages provides any direct guidance for the future handling of space resources, space exploration, or even for resolving the unavoidable and inevitable future issues that will arise when competing interests or major accidents occur in outer space.¹⁴

Therefore, the term “global commons” is overused and misapplied to the space domain. Its use also implies that one single form of governance or control is applicable to all of outer space. Outer space is too many different things and cannot be controlled by one superior authority to oversee and enforce outer space activities.

The two examples taken from policy documents below suggest not a commons, but national or multinational control. The first is from a US Department of Defense publication:

“To enable economic growth and commerce, America, working in conjunction with allies and partners around the world, will seek to protect freedom of access throughout the global commons.”¹⁵

The second is from a NATO workshop release:

“Termed the ‘connective tissue’ of our vibrant global economy, the four domains of the Global Commons - maritime, air, outer space, and cyber space - constitute a universal public good...”¹⁶

These types of broad-brushed uses of very specific legal and economic terminology led to a misunderstanding of the treaties and subsequently led to proposals for legal regimes and the management of space that are virtually impossible to achieve.

Therefore, these phrases and use of terms must be put into context and be better understood before useful progress can be made in managing the next era of activities in outer space.

Global Commons Historically

History shows that the idea of a commons, let alone a global commons, is fragile. None have survived throughout time: some for reasons of political and economic upheavals, and some through major technological advances.¹⁷

The notable Dutch scholar, Grotius, eloquently advanced the concept of the freedom of the seas.¹⁸ But even in the 1600s there was much discussion and dissent regarding the idea that the sea is a commons; not so much when applied to the rights of freedom of passage, but particularly when applied to resources, especially fishing rights on the high seas. These arguments have been expounded in legal literature before Grotius and still prevail today. There really is no authoritative agreement on how to allocate resources in the open

seas, even with the modern technologies that have depleted the supply of some species.

Perhaps the only component of a commons with any traction is the concept of freedom of passage on seas. But even that has been limited by the term, “innocent passage.”

A parallel principle to that found in the law of the seas is Article I of the Outer Space Treaty, which guarantees the “freedom for any nation to access, explore, and indeed use outer space.”¹⁹

Furthermore, there is a logical contradiction in this discussion about outer space being treated as a commons. If a commons needs a sovereign government to grant the open territory to the use of all people, it is that government that oversees, regulates, and enforces that charter. However, Article II of the OST prohibits national sovereignty in outer space, which leads to the conclusion that space is an area

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without a government. Even if all nations regard outer space as a “commons,” it is a very different concept from any commons that has been established in the past. There is no real legal precedent and

no true means of oversight or enforcement, and therefore should not be confused with any of the many ways that concept has been applied to the territory or oceans of the Earth.

Thinking about space as a global commons may be a laudatory ideal, and one that perhaps can only be regarded as a very long-term goal for society. But, it is hardly a practical solution or goal for the problems we face today, witnessed by at least a thousand years of variation in law and practice coupled with radically different production, manufacturing and other technologies, exponential world population growth, and other major political and social changes over time.

But all of the ways we try to phrase “benefits to all mankind,” “province of all mankind,” etc. have their limits. Treaties that provide guarantees such as no sovereignty are not the same as developing more doable and narrower regimes for outer space including permitting ownership through a system of limited or functional property rights, and establishing a doctrine of enforceable national liabilities for activities in outer space.

But attempts to develop some form of overall “governance” of space based on a *res communis* principle will fail in today’s political environment where nations retain the ability to interpret treaty language differently and where widely different cultures and methods of governance exist.

Economic Realities of a Commons

Just as with legal terms, there are economic terms used in association with a concept of a commons that have also been extended beyond their narrow

technical definitions. This adds to misconceptions and may also lead to questionable public policies.

Economics is the study of the distribution and allocation of goods and services that satisfy human wants and that provide utility.

Economists classify goods into categories that are measured by (1) rivalry (the degree to which one person's use of a good prevents others from using the same good) and (2) exclusivity (the difficulty of preventing users from benefiting from a good).

These categories of goods have implications for both pricing and for effective management. The differing degrees of rivalry and exclusivity lead to different incentives, which in turn have an impact on regulatory and government policy. For example, private goods are left to compete in a free market system while those goods and services that would not be forthcoming in a price system, but are deemed to benefit all, are often managed by governmental intervention.

As noted above, outer space is sometimes referred to as a *public good*, i.e. that the use of space (consumption) does not involve rivals and users cannot be easily excluded from engaging in space activities. The idea of non-excludability arises from the Outer Space Treaty, which includes the provision that outer space is free for exploration and access by all countries.²⁰

Since the treaties allow nations the freedom to explore and access space, national governments are able to exclude citizens and even other nations from space activities through technology, pricing, law, and regulation.²¹ Neither condition for a public good exists when applied to outer space, as there already are a number of policy and legal mechanisms in the world that exclude certain users or uses.

There is no single governmental entity that can exert control over all users of space. While some may wish to see the United Nations (UN) become that entity, the reality is that the current international system of governance precludes it. The core unit of sovereign behavior is the nation-state, and states only subject themselves to UN authority when it suits their interests.

The tragedy of the commons, a phrase coined by Garrett Hardin, is the result of the overuse of an area that is open to all to use.²² The most common example is defined acreage available to all citizens to use for grazing cows. When too many take advantage of the area, crowding occurs and none of the users can fully benefit from that land. Managing and governing a commons is difficult but has proven possible under some conditions, most notably when a sovereign government oversees the use of the area and develops a system for peaceful dispute resolution.

A less recognized challenge with economic and legal management of a defined area is the concept of the anticommons. The seminal article on the anticommons was written in 1998 by Michael Heller and discusses the "tragedy of

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the anticommons,” where multiple owners are each endowed with the right to exclude others from a scarce resource, and no one has an effective privilege of use. When there are too many owners holding rights of exclusion, the resource is prone to underuse—a tragedy of the anticommons. Legal and economic scholars have mostly overlooked this tragedy, but it can appear whenever governments create new property rights.²³

In both cases the failure of the commons stems from economic pressures created either by increased population within a defined set of borders demanding more resources and/or by external pressures reducing the supply of scarce resources. A full description of the development of the concept of a commons is well beyond limits of this short paper. However, it is important to highlight that the origins of deeming territory as a commons to benefit all peoples of a particular region or nation likely goes back into pre-historical times and traces its use and development to reasons of necessity, mainly for hunting, fishing, and farming.

Even in Roman times and extending into the Middle Ages, world population ranged from 300 to 500 million people.²⁴ Many of our legal terms used to define and delimit the exact nature of a commons stem from Roman law.²⁵ Even then, over 2000 years ago, it is evident from the multitude of definitions of specific forms of commons (on land, in the oceans, etc.) reflect growing populations and economic problems.

In international law, early scholars looked for what they perceived as “natural law” (unwritten but discoverable law), and found signs of it in both medieval church law, and from earlier Roman law that survived and influenced various European and British legal traditions.²⁶ In this fashion, the artifacts from Roman law were incorporated into concepts in international law.²⁷

Today, with the world population over 7 billion people and growing, it is not surprising that examples of true “commons” are hard to find on a global scale. A successful commons would necessitate a very powerful sovereign and would not last very long if valuable and scarce resources were contained or discovered within its borders.

What is important to note is that all of these legal concepts of a commons need (1) a sovereign power to grant the territory to open use and to then grant whatever rules and limited property rights are necessary for the continued existence of the commons over time, (2) an area of land or a region with well-defined borders, and (3) an economic foundation that requires or facilitates some basic human need (often food) that is more productive or efficiently performed collectively.

Outer space has none of the above. By treaty language, there is no sovereignty in space, as the edges of space are not defined (either where space begins above the Earth or the outer limits of space). And the terrestrial economy may benefit from, but does not need outer space for survival.

This question on the continuing precedential value, or usefulness, of these ancient Roman property concepts is perhaps more salient today for those from non-western countries, such as countries in Asia or Africa, that may have alternative legal and cultural traditions and values.

**Human activity in outer space is not anarchy or uncontrolled:
is it an area of non-governance?**

Human use of outer space is now experiencing a problem of crowding and there is a need for better management to prevent future international problems, issues, and even disasters.

Since nations, by treaty, retain ownership of anything they launch into space and are forever responsible and liable for that property, they have collectively made an international commitment to manage space responsibly.

Certain orbits such as the Geostationary Earth Orbit are very valuable locations in space and more nations now compete for the best locations than there are places to put those satellites. Because not only can satellites be dangerously close to each other, they also require the use of the spectrum for communications purposes. A system for allocating both the

location of satellites and the use of specific spectral bands to avoid accidents and unintentional interference has become essential. An international organization, the International Telecommunications Union, oversees this process through a system of international meetings, negotiations, and agreements. This is an excellent example of limited property rights being granted in the space environment when conditions for operations, private profit, and government use intersect.

Thus, it can be argued that, when necessity compels, human activity in space is governed collectively. However, enforcement of violations of agreements always continues to be a contentious and often difficult problem among states.

On the other hand, since space law is dependent on national legislation to implement treaty agreements, it can also be argued that the interests of the most powerful nations operating in space dominate the system and create a space legal environment that combines economic, political and security issues into a domain that resists compromise and stability.

International attempts of recent years to negotiate even soft law solutions to these issues remain unresolved. Examples include a European-led Code of Conduct, a UNCOPUOS led set of guidelines on long-term space sustainability, and proposals by some nations to the U.N. Conference on Disarmament on a treaty to prevent weapons in space.²⁸ To date, none of these have been successfully negotiated but progress on an international agreement for the United Nations long-term sustainability guidelines is evident.

One exception to this is the 2007 UN Guidelines on Debris Mitigation.²⁹ These guidelines aimed at minimizing future debris in space—and thus hopefully reducing the probability of human created space objects colliding—are being incorporated into national laws. How effective they will be and how can they be internationally enforced remains to be determined.

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Summary of Key Points

First, it is important to note that the most significant problems facing the drafters of the treaties were establishing state responsibility, liability for terrestrial damage, and keeping the use of outer space peaceful and free of weapons of mass destruction. Governments (at first only the United States and the Soviet Union) were the only entities that had the technology to access space, and therefore the key provisions of the treaties focused primarily on launches and on orbital locations. Today's new issues of private sector investment and activities in space as well as activities requiring maneuvering ability in orbit were all hypothetical issues and largely ignored by the treaty regime.

Second, space is considered to be territory without national sovereignty and without specific borders. It is to be used for scientific discovery and for the benefit of all nations. Some have translated this into simple terms such as space as a global commons. However, space itself does not fit the criteria being a commons. It does not have a specifically defined border where outer space begins.³⁰

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large area with little or no gravity. Some of these “things” do have borders and definitions while others do not.

Third, the existence and viability of terrestrial commons depend on the oversight and regulatory power of a sovereign. Most commons arrangements on Earth have not survived over the course of history due to economic pressures and/or governmental changes.

This leads to the conclusion that a terrestrial model of a commons is not a model that can easily be applied to outer space. Space is an

undefined area. No government, nor any combination of selected governments or non-governmental organizations has the power or ability to set rules and regulations to establish and maintain a commons.

Preserving Existing Terrestrial Models as Best Practices

Common Pool Resources

Some recent analyses have attempted to view particular space activities and usage as a form of common pool resources (CPR) instead of a distinct public good.³¹ A CPR is a resource that is sufficiently large where it is difficult, but not impossible, to define recognized users and exclude others. CPRs also exhibit a high level of competition among users. Some classic examples of CPRs are fisheries, forests, underwater basins, and irrigation systems.³²

CPRs have long thought to be the “ideal” case of a tragedy of the commons, but research such as that of Nobel Prize winner Elinor Ostrom dem-

onstrated that is not always the case. She showed the tragedy of the commons could be avoided. Ostrom argued that many CPRs have been successfully governed without resorting to a centralized government or a system of private property, and cites cases where resource users have effectively self-organized and sustainably managed a CPR in spite of centralized authorities and without instituting any form of private property.³³

Ostrom developed an eight-principle framework that outlines the conditions necessary to sustainably manage commons resources without a centralized government or a private property regime. They are:

1. Clearly defined boundaries of the CPR,
2. Congruence between rules and the resource context,
3. Collective-choice arrangements that allow most resource appropriators to participate in the decision making process,
4. Effective and accountable monitoring,
5. Graduated sanctions for resource appropriators who violate community rules,
6. Low-cost and easy-to-access conflict resolution mechanisms,
7. Self-determination of the community, recognized by higher-level authorities,
8. In the case of larger common-pool resources, organization in the form of multiple layers of nested enterprises.³⁴

Ostrom's approach is useful because it is developed for situations where neither of the two traditional solutions to the tragedy of the commons—complete privatization or a Leviathan to impose rule of law—are feasible, as is the case for Earth's orbit.

However, even Ostrom's principles do not address all the challenges of the future of a space regime. They provide only broad outlines of a potential framework and each solution needs to be individually crafted for a specific CPR and its users. That itself requires prior identification of a specific CPR, of which there are many in the context of space, just like there are many on Earth.

Moreover, we cannot characterize all of outer space and its various activities and usages as a single type of economic good that requires a single type of management structure.

International Space Station Agreement

The ISS Agreement, signed in January 1998, is an agreement among 15 partners in building and operating the space station.³⁵ It includes a series of multilateral agreements and has been renegotiated continuously as special needs, technological changes, and other issues have arisen over the years. It is an example that demonstrates that a bottom-up self-governing system for a joint international space program can be successfully executed. Its provisions are fully in concert with the UN space treaties, and a NASA implemented separate code of conduct for the crew of the ISS is a US regulation that each crew member agrees to abide by.³⁶

Although not necessarily a model for the future governance of space, it clearly illustrates that when there is a partnership and a common interest, the participant nations are fully capable of reaching an agreement for both financial and operational requirements of a large, expensive, and long-lasting facility in outer space.

Lunar Heritage Sites

Over time there has been repeated discussion about protecting historical sites on the Moon such as the Apollo landing sites. In July 2011 NASA issued a document that has a number of mainly technical recommendations for achieving this purpose.³⁷ Since the US Government equipment on the moon is considered the property of the United States, the United States can legally protect that property. Of course, the practicality of preventing other nations or private companies from harming this equipment is expensive, difficult, and practically impossible. Nevertheless, the idea that a nation's property in space should be protected is valid since the nation is both responsible and liable for that property in perpetuity. Also now on the Moon are artifacts from the Soviet Union and China with other nations having active plans to travel to the moon and to perform activities there.

One suggestion to resolve this issue without declaring property rights to territory on the Moon is a multilateral international agreement, first agreed upon among those nations with direct current equipment on the moon and then open for any other nations to join when and if they also have successful moon programs.³⁸ A simple verbal agreement among the leaders of those nations to the effect that each will not interfere with property or equipment of the other nations on the moon may be enough to initiate more detailed cooperative discussions and agreements.

As mentioned, another example of international cooperation in resolving commons problems is the regulation of the geostationary orbit locations and spectrum use by the International Telecommunications Union.

In Antarctica, aviation, as well as the high seas, nations have also come to agreement on at least enough common issues to allow for commercial operations and peaceful use of ungoverned, non-sovereign areas. These agreements are not always all-inclusive, nor are they always easily enforced.

However, there is no compelling argument that all issues in such areas need to or can be resolved through one organization or one agreement. Future space issues such as situational awareness, debris mitigation, commercial activities, property rights, etc. will likely be resolved on an ad hoc basis through a series of agreements negotiated by those most directly involved or threatened by international discords.

It is also important for international bodies dealing with space issues such as the UNCOPUOS to continue to negotiate and discuss these same and similar topics. Progress has been made in recent years on both debris mitigation guidelines and on a future agreement on the broader topic of the Long Term Sustainability (LTS) of outer space.

Conclusion

This article demonstrates that solutions to future commercial, security, and legal issues that will face spacefaring nations are possible to achieve in a region where sovereignty is prohibited and where no current overall system of governance exists.

However, what has been discussed are primarily agreements before the fact. If there are serious future accidents in space that involve significant economic, physical, or environmental damage, an international system of fault-based, fact-finding, and compensation will be necessary. Although the current treaties and agreements are cognizant of this possibility, they do not include specific remedies beyond diplomatic negotiations. To date, the space community has been lucky—accidents have occurred but none that have yet done a lot of damage and are of the magnitude that would require a formal enforcement system. Looking ahead, luck is not enough and the existence of an international system for dispute resolution that includes the participation of private enterprise and risk-taking ventures will be necessary.

One such system that exists in other domains includes a regime of binding arbitration, not only implemented in contracts between commercial partners, but also through government action for tortious accidents in space where there are no contractual agreements.³⁹

Since the current dispute resolution systems are admittedly weak, the inclusion of a proven system of arbitration to address in-space issues can help to develop new ways to improve the potential for both incentives to avoid accidents as well as the award of damages if an accident occurs.

A workable system of arbitration (or even one in which states formally recognize the option of arbitration) would be beneficial. It should evolve in the rules and regulations of national regulatory systems. It would be very advantageous if the major spacefaring nations, particularly the United States, Russia, and China agree to initiate this option for settling future disputes in relevant activities in their licensing process, particularly when private enterprises are involved, just as they have for other industries and international economic sectors such as trade agreements, internet domain name disputes, or maritime salvage issues.

Notes

¹ This article is an update and adaptation of an article by the same authors: “How Simple Terms Mislead Us: The Pitfalls of Thinking about Outer Space as a Commons,” 2015 Papers and Proceedings of the International Institute of Space Law: Eleven International Publishing, October 2016, 533–548.

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⁵ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, January 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty]; The Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, April 22, 1968, 19 U.S.T. 7570, 672 U.N.T.S. 119; The Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187; The Convention on Registration of Objects Launched into Outer Space, January 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15.

⁶ UNOOSA, Committee on the Peaceful Uses of Outer Space Legal Subcommittee Fifty-fifth session, Vienna, 4–15 April 2016, *Status and application of the five United Nations treaties on outer space as of 1 January 2016*. A /AC.105/C.2/2016/CRP.3, April 4, 2016.

⁷ The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, December 18, 1979, 18 I.L.M. 1434 [hereinafter Moon Agreement]. Besides the 16 nations that have ratified it, another four are signatories.

⁸ Article XI of the Moon Agreement does provide for a future international organization to be formed to establish governance when and if it would be necessary to allocate permits for the exploitation of the Moon or other celestial bodies.

⁹ The Liability Convention requires diplomatic negotiations to settle claims for damages from space objects (Article IX) and also provides a mechanism for establishing a Claims Commission to settle disputes, if necessary (Articles XIV through XX). However, that mechanism is similar to arbitration and is non-binding without prior agreement. A Claims Commission under the Liability Convention has never been used.

¹⁰ Article II of the Outer Space Treaty.

¹¹ Article I of the Outer Space Treaty.

¹² Preambles to the Outer Space Treaty, Liability Convention, and Registration Convention, *supra* note 2 ("Recognizing the common interest of all mankind in furthering the exploration and use of outer space for peaceful-purposes,"); Moon Agreement, *supra* note 1, at art. II.

¹³ United Nations General Assembly. Resolution 62/101 of 17 December 2007, Recommendations on enhancing the practice of States and international intergovernmental organizations in

registering space objects. United Nations General Assembly. *Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space*, as Endorsed by the Committee on the Peaceful Uses of Outer Space at its fiftieth session and contained in G.A. Res. A/62/20, annex.

¹⁴ One limited exception to this is the use of common heritage in the Moon Agreement with respect to resources. As outlined in many other articles, this has been a very controversial issue. One must also note the lack of acceptance of the Moon Agreement among major space-faring nations, as well as the parallels to the history of Art. XI of the U.N. Convention on the Law of the Seas—where amendments were needed to clarify possible commercial use of the deep seabed when technologies were developed to allow this.

¹⁵ U.S. Dept. of Defense. *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense*, January 2012.

¹⁶ North Atlantic Treaty Organization, *Assured Access to the Global Commons Final Report*, April 18, 2009, accessed September 18, 2015, <http://www.act.nato.int/globalcommons>.

¹⁷ Even Hardin's tragedy of the commons is recognition of this instability and temporary nature of a commons. His examples of various commons are local or regional, not global. Clearly, if a commons cannot be stable for a small area under the control of a sovereign nation, how can it be a stable arrangement for a very large area without sovereignty?

¹⁸ Grotius, Hugo, *Mare Liberum*. Translated by Richard Hakluyt. Indianapolis, IN: Liberty Fund, 2004.

¹⁹ Outer Space Treaty, *supra* note 1, at article I.

²⁰ Article I, Outer Space Treaty

²¹ Note that these exclusions are practical and technological, not legal; the treaties call for nondiscrimination in the freedom of access to outer space for all nations. A principle that still applies, even in the context of economic differences among nations.

²² Garrett Hardin, "The Tragedy of the Commons," *Science*, December 13, 1968, <http://www.sciencemag.org/content/162/3859/1243>.

²³ Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, *Harvard Law Review* (1998): 621–688.

²⁴ United States Census, *World Population-Historical Estimates of World Population* accessed September 6, 2015, https://www.census.gov/population/international/data/worldpop/table_history.php.

²⁵ There are many legal analyses of Roman law. See, for example: Lynda L. Butler, *The Commons Concept: An Historical Concept With Modern Relevance*, 23 *William & Mary Law Review* (1982): 835 available at <http://scholarship.law.wm.edu/wmlr/vol23/iss4/8>.

²⁶ J.L. Brierly, *The Law of Nations* 13 (3rd ed. 1942) ("Thus Roman law reduced the difficulty of finding the contents of natural law almost to vanishing point; and in fact the founders of international law turned unhesitatingly to Roman law for the rules of their system, wherever the relations between states seemed to them to be analogous to those of private persons. Thus, for example, the rights of a state over territory, especially when governments were almost everywhere monarchical and the territorial notions of feudalism were still powerful, bore an obvious resemblance to the rights of an individual over property, with the result that the international rules relating to territory are still in essential the Roman rules of property... We have to inquire further, however, whether this foundation is valid for us today.")

²⁷ *Ibid.*, 119 ("Territorial sovereignty bears an obvious resemblance to ownership in private law, less marked, however to-day than it was in the days of the patrimonial state, when a kingdom and everything in it was regarded as being to the king very much what a landed estate was to its owner. As a result of this resemblance early international law borrowed the Roman rules for the acquisition of property and adapted them to the acquisition of territory, and these rules are still the formation of the law on the subject.")

²⁸ European Union, *DRAFT International Code of Conduct for Outer Space Activities*, VER-SION 31 March 2014, accessed September 13, 2016, http://eeas.europa.eu/non-proliferation-and-disarmament/pdf/space_code_conduct_draft_vers_31-march-2014_en.pdf; UNOOSA, *Guidelines for the long-term sustainability of outer space activities*, Conference room paper by the Chair of the Working Group on the Long-term Sustainability of Outer Space Activities, Committee on the Peaceful Uses of Outer Space, Fifty-ninth session, Vienna, 8–17 June 2016. Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of

Force against Outer Space Objects (PPWT), Proposed to the UN Conference on Disarmament by Russia and China, 2008, accessed September 13, 2016, <http://cfr.org/space/treaty-prevention-placement-weapons-outer-space-threat-use-force-against-outer-space-objects-ppwt/p26678>.

²⁹ United Nations General Assembly Resolution 62/217 of 22 December 2007, *Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space*. These are voluntary guidelines for the mitigation of space debris and reflect the existing practices as developed by a number of national and international organizations.

³⁰ After 50 years of debate in the UNCOPUOS and numerous technical studies, a clear threshold as to what is the edge of the Earth's atmosphere and where outer space begins is still without a precise definition. It is generally agreed that space begins at an altitude of between 90 and 110 kilometer above the Earth creating a legally grey area without a border.

³¹ Brian Weeden & Tiffany Chow, "Taking a common-pool resources approach to space sustainability: A framework and potential policies", *Space Policy*, August 2012, 166–172.

³² "Common-pool resource," Encyclopedia Britannica, <http://www.britannica.com/science/common-pool-resource>.

³³ Elinor Ostrom, *Governing the Commons*, 1998.

³⁴ B. Weeden and T. Chow (2012) "Taking a common-pool resources approach to space sustainability: A framework and potential policies", *Space Policy*, August, 2012 166–172.

³⁵ AGREEMENT AMONG THE GOVERNMENT OF CANADA, GOVERNMENTS OF THE MEMBER STATES OF THE EUROPEAN SPACE AGENCY, THE GOVERNMENT OF JAPAN, THE GOVERNMENT OF THE RUSSIAN FEDERATION, AND THE GOVERNMENT OF THE UNITED STATES OF AMERICA CONCERNING COOPERATION ON THE CIVIL INTERNATIONAL SPACE STATION, NASA, Office of the General Counsel, January 1998. accessed September 14, 2016, <ftp://ftp.hq.nasa.gov/pub/pao/reports/1998/IGA.html>.

³⁶ "Rules and Regulations," *Federal Register* 65, no 246 (December 21, 2000): 80302–8030.

³⁷ NASA Recommendations to Space-Faring Entities: How to Protect and Preserve the Historic and Scientific Value of U.S. Government Lunar Artifacts, July, 20 2011.

³⁸ H. Hertzfeld and S. Pace, "International Cooperation on Human Lunar Heritage", *Science*, November 29, 2013, 1049.

³⁹ H. Hertzfeld and T. Nelson *Binding Arbitration as an Effective Means of Dispute Settlement for Accidents in Outer Space*, Beijing, China, International Institute of Space Law, IAC-13.E7, 2.1x17590, September 2013.