# The Artemis Accords and space weaponization: A commons approach

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## Abstract

The Artemis Accords are an international agreement first drafted by NASA and the US government that aim towards establishing a framework for civil space activities by civil space agencies regarding the Moon, Mars, asteroids and comets. The Accords have been signed by multiple states, in particular those that are willing to play a role in the US-led Artemis Program for renewed human spaceflight to the Moon. The Accords have been controversial among experts in the field of space governance. Experts have claimed that the Artemis Accords do not respect space as a commons and that the Accords have important shortcomings that hamper its ability to facilitate sustainable space governance. Others have primarily criticized the Artemis Accords for the tensions it has increased between the US and states like Russia or the PRC, as some believe the US are actively trying to influence the governance of space in their favour. Some fear that this can lead to attempts to overtly weaponize space. This research aims to look at both of these criticisms, by first assessing to what extent the Artemis Accords comply with or violate the principles associated with sustainable governance of a commons and looking at the Accords and its contents in detail. Then, the effects this has on the weaponization of space will be considered and discussed in order to better understand how the Artemis Accords are influencing the weaponization of space.

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## Introduction

In 2020 the United States (US) announced the creation of an agreement known as the Artemis Accords, a historical development for space governance. The Accords are primarily concerned with the governance of the Moon in light of the US-led Artemis Program, although they also concern themselves with the governance of Mars, the asteroids and comets. The Accords aim to create a common vision on the exploration and use of these areas of space. With the Artemis Accords, the US are trying to influence space governance through norm setting and the usage of soft power to create soft law (Johnson, 2020; Vazhapully, 2020) in order to advance their strategic interests (Boley & Byers, 2020). For this to be effective, other states will have to recognise the principles set out by the Artemis Accords and the US have made no secret of their aim to have more states become signatories of this agreement (Vazhapully, 2020). The US have built the Accords upon the foundations of previous treaties on space, with the aim of influencing the interpretation of these treaties to comply with US interests, which is possible given the ambiguous nature of these treaties (Fidler, 2020; Vazhapully, 2020). As of the time of writing, the Artemis Accords have been signed by 14 states, with Mexico being the latest signatory, signing the agreement on the 10th of December (Foust, 2021). There exists quite some controversy around the Accords, mainly regarding the tensions it has caused (Boley & Byers, 2020) and how it proposes to govern space, which goes against the principle of space as a commons (Vazhapully, 2020). This research will try to look at both of these criticisms and see if they may be related to each other.

## Literature Review

As stated previously, the Accords are quite controversial and some of the most important states in space affairs, such as Russia, India and the People's Republic of China (PRC) have not signed the Artemis Accords, with Russia and the PRC openly criticizing the Artemis Accords due to them being too US-centric (Boley & Byers, 2020). This is particularly noteworthy when looking at space as a military domain, where the 'global superpowers' are the most capable and important actors (Johnson-Freese & Burbach, 2019). Therefore, it is incredibly important for negotiations and agreements on space to involve these states as otherwise conflicts may arise, which could lead to the weaponization of space (B. Li, 2020). The international community has been concerned with the issue of space weaponization for years and efforts have been made to convince states to keep space unweaponized as it benefits

all, seeing as it provides more safety for all states (Hao & Tronchetti, 2016) as well as it preventing an arms race in space, which would incur large resource costs to those involved (Lauder, Klotz & Courtney, 2020). While the Artemis Accords concern the civilian use of space, they also have implications on the weaponization of space, given its controversial contents can lead to further tension in space, which could lead to weaponization (Boley & Byers, 2020; B. Li, 2020). With the absence of signatories like the PRC and Russia, tensions between these powers and the US could increase, which could lead to further efforts to militarize and possibly weaponize space (B. Li, 2020).

Space is generally understood to be a commons area (Boley & Byers, 2020). When looking at space as a global commons, the contributions of Elinor Ostrom on the CPR approach need to be recognised. Ostrom introduced us to her design principles, principles that robust institutions abide by when governing a CPR resource effectively (Ostrom, 2015). As the aim of the Artemis Accords was to act as such an institution, it makes sense to test to what extend the Accords comply with these design principles. While the Artemis Accords have been analysed before by several authors who have noted its shortcomings and positive elements (Boley & Byers, 2020; Tronchetti & Hao, 2021; Vazhapully, 2020), it seems that thus far they have not been analysed and tested to these principles and their influence on space weaponization has also not been more thoroughly explored. By testing the Artemis Accords to these design principles, especially when looking at the implications this holds for the weaponization of space, it will likely be possible to better understand what the shortcomings of the Accords mean for the weaponization of space and how this has been influenced. This could lead to valuable lessons regarding the design of institutions for space governance. Therefore, the main research question of this thesis will be: “How well do the Artemis Accords comply with the design principles that successful governance institutions for commons abide by?”. The follow up question to this is: “What are the possible implications of this with regards to the weaponization of space?”.

This is practically relevant, since policy makers can make use of the knowledge that can be gained by using the CPR approach towards the Artemis Accords and their influence on the weaponization of space in order to propose informed and effective policies and institutions in the future. Furthermore, answering these questions could show how important it is to involve important appropriators in space governance institutions and how this could potentially help the institution to function effectively and minimize the risk of space weaponization. It is also relevant in an academic sense, as this analysis can be used as a stepping stone for future

research on the Artemis Accords and other important space treaties and agreements. An example of this could be a more detailed research on how the institutional design of other important space treaties and their compliance to the design principles have influenced the weaponization of space.

When analysing the Artemis Accords from a CPR approach, it is important to note that the US have explicitly rejected the idea of space being a global commons (Tronchetti & Hao, 2021; Vazhapully, 2020). Some claim that the US explicitly disregarded much of the knowledge that has been gained on managing a global commons in order to further their own strategic interests, with effective space governance being a sacrificial lamb for these ambitions (Boley & Byers, 2020). However, the US not viewing space as a global commons does not change the fact that many experts in the field of space governance still believe they are and that they were originally intended to be viewed as such (Tronchetti & Hao, 2021; Vazhapully, 2020). In other words, while the Artemis Accords may not have been designed with the idea of a global commons in mind, it does not mean that it cannot be analysed from this perspective. In fact, it might even lead to new insights on the Artemis Accords itself and could inform future policy makers on the importance of viewing space governance from multiple and different approaches, as this can lead to a better understanding of a policy area and thus to better policy (Brando et al., 2019).

## Theory

Utilizing a commons or CPR approach means analysing a good as a common-pool resource (CPR), which is a resource that has an open access problem, meaning it can in most cases be accessed by everyone, and that has a 'subtractability' characteristic, meaning that when one appropriator takes away from the resource, it cannot be accessed by another appropriator (McGinnis & Ostrom, 1992; Weeden & Chow, 2012). In other words a CPR has both elements from public goods and private goods. A CPR is generally non-excludable, meaning it is hard to control who has access to the resource, a characteristic it shares with public goods (Adams & McCormick, 1987; McGinnis & Ostrom, 1992; Ostrom, 2003). A CPR is also a rival good, meaning that the exploitation of the resource by one appropriator prevents another appropriator who potentially wants to exploit the resource at the same time from doing so, which is a characteristic they share with private goods (Adams & McCormick, 1987; McGinnis & Ostrom, 1992; Ostrom, 2003). The origins of the commons approach finds itself

in an article written by Hardin (1968) called ‘the tragedy of the commons’. In this article he discusses a collective action problem that arises when a finite resource is used by multiple appropriators, where every appropriator wants to achieve the maximum amount of that resource, but it is in the interest of everybody to not overstep the boundary of the finite resource as this would lead to reduced benefits for all (Hardin, 1968).

While Hardin (1968) believed that the most important solutions to these problems where government intervention and privatization, as then either a centralized government or market interference would be able to prevent appropriators from overstepping boundaries, Ostrom disagreed with this. She believed that such collective action problems could also be overcome by appropriators themselves without top-down approaches or market interference, as appropriators could come up with rules and manage their own behaviour (McGinnis & Ostrom, 1992). This notion of appropriators managing their own behaviour is useful when discussing policies on space governance, as this is traditionally done among states themselves through bilateral or multilateral agreements (Rajagopalan, 2021). In the anarchical setting of international politics, it is important that states can find solutions amongst themselves in the absence of an overarching authority and since the approach by Ostrom (2015) is specifically tailored towards analysing this, it is applicable for analysing space governance (Weeden & Chow, 2012).

Ostrom recognized that a bottom-up approach, with a commons being managed by the appropriators that make use of it, also comes with its own difficulties and challenges, which she addressed in multiple articles (McGinnis & Ostrom, 1992; Ostrom, Burger, Field, Norgaard & Policansky, 1999). One of her contributions included a set of design principles that must be fulfilled in order to manage a CPR in an effective manner (Ostrom, 2015). According to Ostrom (2015, p. 90), these are the following eight design principles:

1. Clearly defined boundaries of the CPR (effective exclusion of external unentitled parties);
2. Congruence between governance structure or rules and the resource context;
3. Collective-choice arrangements that allow most resource appropriators to participate in the decision making process;
4. Effective monitoring by monitors who are part of or accountable to the appropriators;
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.

In order to assess how effective the Artemis Accords can be towards managing space as a commons, it makes sense to test them on these principles and see how well they fulfil the criteria set by Ostrom (2015). However, in order to use this approach, what constitutes the CPR in this research needs to be made clear. A global commons such as space generally consists of many different CPRs, individual resource extraction areas such as for example fisheries and oil fields in the global commons of the oceans (Weeden & Chow, 2012). For this research, there will be a focus on the CPR of the Moon and Mars and their orbits, comets and asteroids, as these are the areas that the Artemis Accords concerns itself with. While this resource area is incredibly large, it is also limited, there is only one Moon, one Mars and a select number of comets, asteroids and orbital trajectories available at a time. This means that not all appropriators can make use of the same resource at the same time, given that there is only a limited amount of space available at a time for extraction, exploration, the placement of satellites or the placement of weapons. When analysing the Accords from a commons approach, how it governs this 'Moon, Mars, comets and asteroids' CPR will be tested against the design principles by Ostrom (2015).

While analysing the Artemis Accords through a commons approach and testing it to the design principles by Ostrom (2015), it is also possible to look at the tensions that it has caused between the US and other powerful states (Boley & Byers, 2020). Understanding where the Artemis Accords fall short on complying with the design principles of Ostrom (2015) can grant us insights on why the Accords are generally considered a problematic institution and why these tensions exist (Boley & Byers, 2020; Vazhapully, 2020). This is particularly important with regards to the weaponization of space, where mutual trust is an important part of preventing weaponization and possible arms races (B. Li, 2020). By looking at the example of the Artemis Accords it will also be possible to analyse how important the principles of Ostrom (2015) can be in preventing the weaponization of space and preventing increased tensions between appropriators through future proposed institutions (Weeden & Chow, 2012).

In order to discuss the weaponization of space, what constitutes a space weapon should first be defined. This is a challenging task, entire groups of experts have discussed this issue reaching little agreement (Krepon, 2010). A challenging aspect of defining space weapons is the fact that most space technology is considered to be dual-use in nature, meaning that it can

be used for both civilian and military ends (Johnson-Freese & Burbach, 2019). An example of this could be a simple communications satellite changing its orbit in order to harm the satellite infrastructure of another state. This means that distinguishing between what constitutes a weapon or not is a challenging task, as space technology generally possesses characteristics of both (Johnson-Freese & Burbach, 2019). Another important question is whether earth based weapons with the aim of taking down satellites can be seen as space weapons (Hao & Tronchetti, 2016; Johnson-Freese & Burbach, 2019). This is hotly debated, which becomes evident when looking at UN resolutions proposed by Russia and the PRC on the weaponization of space, which did not define ground based Anti-Satellite (ASAT) weapons to be space weapons (Hao & Tronchetti, 2016; Johnson-Freese & Burbach, 2019). This was not received well by the US, especially since both Russia and the PRC are pursuing these weapons, which was one of the reasons these resolutions did not enjoy endorsement by the US (Hao & Tronchetti, 2016; Johnson-Freese & Burbach, 2019).

When looking at space through the lens of a global commons, the appropriators in space can be divided into spacefaring states, space-capable states  and space users. (Weeden & Chow, 2012). When discussing the weaponization of space, most attention will be put towards those appropriators that can be considered spacefaring states, as these are the states that possess the means to maintain missions in space on their own (Weeden & Chow, 2012). Therefore they are the ones that most likely would have the means to weaponize space and are thus most important for discussions on the subject (B. Li, 2020).

## Research Design

This thesis will take on the form of a descriptive research, as it aims to describe how well the Artemis Accords comply with Ostrom's (2015) design principles and how this relates to the topic of space weaponization. This will be done by the means of a qualitative content analysis of the Accords and its sections, which will be the units of analysis. This qualitative content analysis will aim to look at the sections of the Accords, what they mean, how they can be interpreted and how they stand in relation to their political and institutional environments. This will be done in order to sort the sections between being relevant or not for a design principle by Ostrom (2015) so that an assessment can be made on whether the Artemis Accords comply with a design principle or not. A qualitative content analysis is well-suited for this, as there is an emphasis on the possibility to extract categories out of data and on

‘understanding the meaning of the context in which an item being analysed (and the categories derived from it) appeared’ (Bryman, 2004, p. 542). This means this approach can not only aid in distinguishing and understanding relevant sections, but also helps us take into account the context of the Accords which are not mentioned in the texts so that possible shortcomings can be more easily identified (Kohlbacher, 2006). The design principles by Ostrom (2015) will be discussed in order, there will be a short elaboration on the principle itself, followed by a discussion of the relevant sections of the Accords and to what extent they fulfil the principle. Where necessary, references will be made to how space governance has generally handled the principle, in order to gain a better understanding of whether the Artemis Accords have improved on this or not. This way, the Accords can be tested against the design principles similarly to how Ostrom (2015) tested other institutions to her principles. After testing the Accords to each design principle, there will be a short conclusion of the results followed by a discussion on how these results are related to space weaponization in order to answer both research questions.

Seeing as the US has publicly declared that it does not see space as a commons area, it seems unlikely that it has made a deliberative effort to ensure the Artemis Accords fulfil the design principles by Ostrom (2015). This, taken together with the fact that the contemporary institutions that govern space also suffer from shortcomings (Weeden & Chow, 2012), leads to the first hypothesis of this thesis, namely that the Artemis Accords do not comply with the design principles enough to be a successful institution. With regards to the second question on how this influences space weaponization, as mentioned previously, important factors to minimize weaponization risks are trust and mutual cooperation (B. Li, 2020). This has an interesting overlap with CPR institutions, given that these function effectively based on similar factors. An appropriator in a commons will generally only abide by the rules if he trusts other parties will do so too (Ostrom, 2015). Furthermore, as will be discussed later, appropriators in a commons generally need to cooperate with each other to ensure other parties abide by the rules, as they need to for example collectively monitor the behaviour of others in order to know whether the governance structure functions as intended (Ostrom, 2015). Therefore, a successful institution for governing a commons facilitates building trust and cooperation to a certain degree. This leads to the hypothesis of the follow-up question, if the Artemis Accords do not comply with the design principles, they cannot effectively facilitate trust and cooperation between appropriators, which increases the risk of space weaponization.

## Analysis

In the following sections, there will be a further elaboration on the design principles of Ostrom (2015). After discussing them, the Artemis Accords will be analysed in-depth in order to assess to what extent they complied with the principle. All principles will be discussed in order, except design principle 7. This is due to the fact that design principle 7 regards the rights of appropriators to devise their own institutions and not be challenged by higher authorities (Ostrom, 2015), but this is already fulfilled in the anarchical international system with Westphalian sovereignty for states and therefore does not require to be discussed in detail (Hayman & Williams, 2006; Niou & Ordeshook, 1990). Design principle 4 and 5 will be discussed together given their similarities and relationship. Finally, a coding scheme will be provided that will display whether the Artemis Accords complied with the design principles and which sections of the Accords are relevant for this.

### 1. Clearly defined boundaries

The first design principle that long-enduring CPR institutions abide by is that they clearly define the boundaries of the CPR. This includes the physical boundaries of the CPR as well as a definition of who the relevant appropriators of the CPR are (Ostrom, 2015). This is necessary, as without these boundaries who and what is being managed remains unclear. The necessity of this principle becomes clear when considering the fact that when certain resource appropriators take measures to prevent overconsumption of the CPR and others do not, the latter will have a comparative advantage. This would lead to appropriators disregarding the necessary efforts to limit the overconsumption of a CPR and thus institutional failure (Ostrom, 2015).

The Artemis Accords set their boundaries in section 1, where it is stated that its principles apply to ‘civil space activities conducted by the civil space agencies of each Signatory’ (NASA, 2020, p. 2), defining the involved appropriators. Furthermore, section 1 also shows the physical boundaries of the CPR, these being ‘the Moon, Mars, comets, and asteroids, including their surfaces and subsurfaces, as well as in orbit of the Moon or Mars, in the Lagrangian points for the Earth-Moon system, and in transit between these celestial bodies and locations’ (NASA, 2020, p. 2). This shows that the Artemis Accords have a defined physical boundary, albeit a flexible one given that these objects are constantly moving. While

the appropriators bound by the Accords are clearly defined, the Accords do not directly apply to corporations, which could be a shortcoming given that while traditionally the only real 'space farers' have been states, recently, private companies like SpaceX and Blue Origin have also managed to commence their own space operations (A. S. Li, 2021). Therefore, it is likely that the traditional view of states as the only appropriators able to sustain themselves in space will have to change for effective space governance in the near future, as private organisations are increasingly more adept at appropriating resources. Therefore, while the Artemis Accords adhere to the first design principle to a large degree, some shortcomings do exist, particularly in defining the relevant appropriators.

## 2. Congruence

The second design principle relates to the compatibility of the structure of governance with the context of the resource that should be governed. Logically, making general claims on this principle is not easy, since it depends heavily on the specific analysed CPR. The central idea behind this principle is that governance structures and rules are adapted to their context, such as by recognising resource-specific circumstances (Ostrom, 2015).

In order to assess how well the governance structure of the Artemis Accords complies with its space context, general features of space have to be taken into account. These features include the complexity of space, the transversality of space, its long-term nature, the large number of involved appropriators and the need for sustained dialogue between appropriators in order to build relationships and trust (Rieder, Bruston, Mathieu & Schrogl, 2009). The Artemis Accords have mostly taken these features into consideration. They take the need for sustained dialogue and cooperation to build trust into consideration in section 2, which reveals a possibility for shared missions between appropriators and section 4 regarding transparency. The large number of involved appropriators is also recognised in section 10 regarding space resources. Section 11 gives a clear example of how the Artemis Accords have taken the special circumstances of the CPR into consideration, stating that the United Nations Guidelines for the Long-term Sustainability of Outer Space Activities need to be taken into consideration, but that appropriate changes might have to be made in order to keep the guidelines relevant for missions beyond low-earth orbit (NASA, 2020). The recognition of the long-term nature of space missions is implied in for example the preamble 'SHARING a common spirit and the ambition that the next steps of humanity's journey in space inspire

current and future generations to explore the Moon, Mars, and beyond' (NASA, 2020, p. 1). Transversality is also implied in for example the preamble 'NOTING the benefit for all humankind to be gained from cooperating in the peaceful use of outer space' (NASA, 2020, p. 1). Therefore, the Artemis Accords abide by the second design principle of Ostrom (2015).

## 3. Collective-choice arrangements

The third design principle relates to the importance of including relevant appropriators in the decision making process. According to Ostrom (2015) if affected appropriators are able to modify the operational rules, rules will be more adapted to the specific circumstances of the CPR. Ostrom (2015) mainly refers to how this helps governance adapt to changing local circumstances over time, something particularly relevant in the governance of space, as space-faring capabilities have been evolving in a rapid pace and are becoming increasingly accessible (Weeden & Chow, 2012). Ostrom (2015) also argues that the costs of changing the rules should also be kept low in order to achieve good governance, as it helps keep the rules more aligned with the current governance needs.

The Artemis Accords do not comply with this third design principle and this is one of their major shortcomings. The Accords were drafted by the US and did not go through the UN, like most other important treaties on the governance of space (A. S. Li, 2012; Weeden & Chow, 2012). Instead, the US lets other states sign the Accords that it has drafted unilaterally and has even declared that potential partners that wish to cooperate with the US in the Artemis Program will have to be signatories to the Artemis Accords (Vazhapully, 2020). This means that other important appropriators in space governance were not consulted and that there might be signatories to the Accords that do not actually believe in its principles, but instead did so in order to participate in the Artemis Program. Furthermore, while section 13 does mention that 'the Signatories commit to periodically consult to review the implementation of the principles in these Accords' (NASA, 2020, p. 7) there seems to be no mechanism to adapt the principles in the Artemis Accords. All in all, these factors lead the Artemis Accords to contain hard to change principles developed unilaterally that could possibly only be changed in a costly manner, while signatories potentially do not believe in the principles of the Accords and other important potential signatories are missing. Therefore, the Artemis Accords do not comply with the third design principle.

## 4&5. Effective Monitoring and Graduated Sanctions

The fourth and fifth design principle relate to the monitoring of appropriators and the graduated sanctions that appropriators can be subjected to if they violate the rules. As Ostrom (2015) mentions in her text, both the monitoring and sanctioning in a CPR institution are undertaken by the appropriators themselves instead of external authorities. The willingness of appropriators to invest in this monitoring and sanctioning can be understood following the logic of 'quasi-voluntary compliance', the idea that appropriators will willingly comply with laws and rules so long as they know others will comply too. Here, monitoring not only grants information to the appropriators on who complies with the rules, but also if the rules are still well adapted to the resource context and work as intended or whether the rules or individual behaviour by the appropriator should be changed (Ostrom, 2015). Furthermore, enforcement of the rules can aid in the confidence of appropriators that other appropriators will also abide by the rules, which can aid in voluntary compliance (Ostrom, 2015). Another important aspect of the sanctions and enforcement in a CPR is that they can be graduated, meaning that they can vary in severity depending on circumstances (Ostrom, 2015). As Ostrom (2015) has shown, flexibility in sanctioning can be a good thing for good governance over a CPR, with more lenient sanctions for limited, one-time transgressions and more harsher punishment for repeated transgressions in cases where this is not necessary. In some scenarios, a simple "naming and shaming" of an appropriator suffices and can lead to better compliance in the future.

The Artemis Accords make mention of monitoring space activities in several of its sections, such as section 4, 7, 8, 10 and 11. Important to note is that the Artemis Accords rely on the involved appropriators reporting to other appropriators on a mostly voluntary basis, asking only of a commitment to disclose important information to other signatories, the public or the UN. While structural monitoring by other appropriators is not explicitly mentioned, section 11.8 mentions that signatories can request other signatories to share information on the basis of a safety zone area, implying that monitoring by signatories on the activities of other signatories is possible and in accordance with the Accords. Therefore, the Artemis Accords comply to a large degree with the fourth design principle.

When discussing graduated sanctions, an example of how the 'naming and shaming' approach can work can be seen when looking at Chinese ASAT tests conducted in 2007 and 2010 (Weeden & Chow, 2012). In 2007 the PRC conducted an ASAT test by shooting down one of

its satellites, which was not announced in advance to other appropriators and created a large debris field that endangered satellites and missions (Weeden & Chow, 2012). States communicated their concerns towards the PRC over this test, mostly through private diplomatic channels. The US then conducted their own tests in 2008, with prior communication and the aim to create as little debris as possible. These turned out to be effective sanctions, as a later Chinese test in 2010 was done with prior communication and a higher concern to limit dangerous debris (Weeden & Chow, 2012). This shows that in space governance, the "naming and shaming" approach to sanctions can be effective in governing the CPR. However, other heavier sanctions could be quite costly (Weeden & Chow, 2012), meaning that enforcement of the rules could be harder if moderate sanctions do not have the desired effect.

When looking at the sanction possibilities of the Artemis Accords, it becomes clear that there are little formal rules regarding the enforcement of the Accords. As just discussed, this is not necessarily a bad thing, as it means that there is a large degree of flexibility on sanctions. Section 11 of the Accords grants signatories the possibility to ask for clarification on why appropriators have designated an area a 'safety zone', which grants signatories the opportunity to, if they so desire, raise critical questions on whether the reasoning for this abides to the aims of the Artemis Accords (NASA, 2020). Section 13 gives signatories the opportunity to periodically discuss among themselves whether the implementation of the principles of the Accords have had the desired effect. This also grants appropriators the possibility to critique other appropriators that have acted against the Accords, meaning the 'naming and shaming' approach is possible through this approach. This means that, especially for smaller, one time transgressions, the Artemis Accords have a build-in system to address issues and harm the reputation of appropriators that do not abide by the rules. However, there are no possibilities to impose harder sanctions through the Artemis Accords themselves, meaning that there is a risk that the Accords cannot adequately deal with appropriators that repeatedly or harshly transgress the rules. While this 'naming and shaming' approach has traditionally been the main enforcement mechanism in space governance, the question remains whether this will be enough to deter gross violations in the future. The recent Russian ASAT test seems to indicate that perhaps the 'naming and shaming' approach is not a strong enough enforcement mechanism to deter heavy transgressions violations (Bugos, 2021). The developments after the Russian ASAT test seem to go against the idea that the 'naming and shaming' of the PRC in its past ASAT test can actively change the behaviour appropriators, as

concerns over this test were widely made public in formal diplomatic communications (Bugos, 2021). Therefore, while the Artemis Accords comply with the fifth design principle on important areas, it also has shortcomings regarding the possibility for stronger sanctions against heavy and repeated transgressions and therefore only partly fulfils this principle.

## 6. Conflict resolution mechanisms

The sixth design principle by Ostrom (2015) regards mechanisms to resolve conflicts among appropriators. Ostrom (2015) mentions how in practice there can be disagreements regarding how operational rules should be interpreted. Therefore, mechanisms need to exist in order for appropriators to discuss their understanding of the rules and how to apply these. If such a mechanism would not exist ambiguous rules could easily be circumvented, which means these rules would be ineffective. Furthermore, if there is no recognition for situations where a rule has been broken by accident or necessity, rules can be seen as unfair, which could lead to lower compliance. These resolution mechanisms have to be efficient, be low-cost and quick at resolving conflicts and can be informal, formal or both (Ostrom, 2015).

The Artemis Accords contain multiple sections that grant mechanisms to resolve conflict. This can be seen most clearly in section 13, calls upon signatories of the Accords to consult among each other on the implementation of the principles of the Accords (NASA, 2020). During such consultations the signatories can discuss how principles should be understood or redefined if necessary. They could also discuss scenarios in which rules were broken unwillingly and what the consequences of this should be.

Furthermore, section 2 of the Artemis Accords describes that the Accords can also be implemented through bilateral instruments between signatories and that such instruments need to contain provisions that regard questions of liability (NASA, 2020). Therefore, while not a conflict resolution mechanism in the Artemis Accords themselves, section 2 does require signatories to implement such mechanisms in bilateral agreements or other instruments that would coordinate bilateral cooperative activities.

In contemporary space governance, conflict resolution mechanisms do exist, but remain hardly used or ineffective (Weeden & Chow, 2012). The primary method for conflict resolution has been bilateral negotiations between states(Weeden & Chow, 2012). Therefore, while the Accords do not fully comply with the design principle of Ostrom (2015), this has

been a general problem in space governance. Section 2 of the Artemis Accords might have set an important step forward in the field, as it directly recognises that bilateral negotiations are the primary manner for conflict resolution in the field. By encouraging signatories to enter bilateral agreements that have dedicated rules towards liability, the Artemis Accords take encourage the creation of agreements on this field before conflicts arise, which can help in reducing costs. This is an improvement over the current mechanisms. Therefore, while the Artemis Accords do not fully satisfy the sixth design principle by Ostrom (2015), they are an improvement over the current mechanisms, therefore the sixth design principle seems to be mostly fulfilled given the possibilities to make conflict resolution both faster and cheaper.

## 8. Nested enterprises

The eighth and last design principle by Ostrom (2015) concerns itself with governance structures, as Ostrom (2015) argues that agreements and institutions need to have a levelled structure in complex CPRs. This is due to the fact that managing the commons through one level would be ineffective given the large variety of challenges in managing complex CPRs. On the other hand, having multiple arrangements and institutions to manage aspects of a CPR also does not function in practice if these do not coordinate with each other. In short, complex CPRs need to be governed through multiple levels of nested enterprises, where their rules are reflected or supplemented by rules on other levels (Ostrom, 2015; Weeden & Chow, 2012).

The Artemis Accords are part of the general governance structures that exist to govern the CPR of space. It exists itself as a nested enterprise and recognises other nested enterprises and their rules. This can be seen in multiple sections in the Artemis Accords, such as in section 1, 3, 4, 6, 7, 10 and 11, which recognise previous important treaties and institutions that govern space, such as the Outer Space Treaty (NASA, 2020). The Artemis Accords also recognise the need for nested enterprises on a level beneath the Accords themselves. This is seen in section 2, which outlines how the Accords should be implemented in specific missions or other cooperative activities and how states need to ensure entities acting on their behalf also comply with the Accords (NASA, 2020). This last point is important, given that in space governance a large amount of interstate agreements have to be applied in national legislation in order for them to also apply on other entities than states, as states have been defined as the primary authority in space in previous treaties (Weeden & Chow, 2012). This has led to problems, as some states have not applied the treaties and agreements in their national legislation yet

(Weeden & Chow, 2012). This enables non-state actors, such as corporations, to look for states that do not adequately enforce international agreements and treaties(Weeden & Chow, 2012). This problem is not addressed by the Artemis Accords, which means that the multi-levelled system still holds flaws in it. Although the Artemis Accords do not fully comply with the eighth design principle for this reason, they do comply to such an extent that the eighth design principle by Ostrom (2015) can be considered fulfilled.

| Ostrom's (2015) Design Principle Number | Artemis Accords | Relevant Sections |
|---|---|---|
| 1 | Partly Fulfilled | 1 |
| 2 | Fulfilled | Preambles, 2, 4, 10, 11 |
| 3 | Not Fulfilled | 13 |
| 4 | Mostly Fulfilled | 4, 7, 8, 10, 11 |
| 5 | Partly Fulfilled | 11, 13 |
| 6 | Mostly Fulfilled | 2, 13 |
| 7 | Fulfilled | N/A |
| 8 | Mostly Fulfilled | 1, 2, 3, 4, 6, 7, 10, 11 |

**Figure 1.** Coding Scheme Artemis Accords (NASA, 2020).

As can be seen in the coding scheme, the Artemis Accords only violate the third design principle by Ostrom (2015). The first and fifth design principles are partly fulfilled, the Artemis Accords are not complete enough to fulfil the requirements but do still abide by the basic requirements of the design principle. The other design principles are fulfilled or fulfilled to such a degree that problems are unlikely to arise. This is also in line with the first hypothesis, that the Artemis Accords do not fulfil all requirements of Ostrom's (2015) design principles.

## Discussion Weaponization

So as can be concluded from a deeper analysis of the Artemis Accords, the Artemis Accords do not comply with all of Ostrom's (2015) design principles, meaning that it will likely not succeed as a means to sustainably govern the CPR. This violation of principles also has consequences for the weaponization of space. The Artemis Accords apply only to civil space activities by civil space agencies, but that does not mean that the Accords have no effect on the weaponization of space. This is due to two factors, namely the tension the Accords have caused among the important space-faring states, which relates closely to the violation of the third design principle. The second factor regards the methods states could use to weaponize space while seemingly abiding the Artemis Accords because of their incomplete enforcement mechanisms and the fact that not all relevant appropriators are included, which relates to the first and fifth design principle.

The first factor relates to the tension created between important spacefaring states, such as Russia and the PRC, which is partially due to the violation of the third principle of Ostrom (2015). Tension between the US and the PRC on the field of space have increased in recent years, through for example the US adopting the Wolf amendment, which effectively forbids NASA to cooperate with Chinese companies or the PRC itself in order for the US to remain superior in the space domain (Handel-Mazzetti, 2021). The PRC has been sceptical of US efforts to establish frameworks for space governance, as they believe these efforts are aimed at preventing or delaying the PRC's efforts to become a dominant actor in space (Stimers & Jammes, 2021). The tension between the US and Russia has also increased, with Russia increasingly looking to cooperate with the PRC instead of the US as it believes the accords to be too US-centric (Stimers & Jammes, 2021). This has led to the PRC and Russia announcing their own plans for a lunar research program together with other states, independent of the Artemis program (Stimers & Jammes, 2021), which means cooperation seems unlikely between the US and Russia and the PRC. This is unfortunate when taking into consideration the weaponization of space, given that distrust and tension can lead to weaponization, while cooperation and trust-building can help alleviate it (B. Li, 2020). The Artemis Accords could have served as a means to promote trust and cooperation between these spacefaring states, especially given the fact that the PRC has publicly declared that a framework like the Artemis Accords could be beneficial for the exploration of space (Stimers & Jammes, 2021). If the third principle of Ostrom (2015) had been upheld and important spacefaring states like the PRC and Russia had been consulted during the drafting phase, the Accords could have been a

wider agreement with more signatories, while at the same time reducing tensions, increasing cooperation efforts and increasing its ability to set norms given the wider support (Johnson, 2020). This would likely have meant a significant change of the Accords, in particular to section 8 regarding 'safe-zones' seeing as these are heavily contested (Schingler, 2020), but it would have resulted in the Accords becoming a more successful institution for sustainable space governance. Apart from this, tensions would likely have been lower, with possibilities for the largest space-faring states to cooperate and thus mitigate the risk of weaponization of space (B. Li, 2020). It might have even been a better agreement from an American strategical perspective, given that the PRC often resorts to creating their own institutions when it does not wish to participate in the institutions of others (Stimmers & Jammes, 2021), which has strengthened the Chinese position in space in the past (Handel-Mazzetti, 2021).

The second factor regards the incomplete definition of appropriators in section 1 and the difficulties for stronger enforcement mechanisms for the Accords, which relates to the first and the fifth design principles of Ostrom (2015). Firstly, as discussed previously non-state actors are not seen separately from the state they are based in. This means that states have the primary responsibility to regulate the behaviour of for example corporations, which are an increasingly important player in space. The problematic outcome of this is that states would have to regulate the behaviour of these corporations, even though it might be in their interest if the operational rules are breached. This is worsened further due to the dual-use principle, the idea that civil or even commercial objects in space such as satellites could be utilized for military purposes and arguably as weapons, which further increases the interests states might have in corporations reaching a stronger position in space than they are intended to (Johnson-Freese & Burbach, 2019). Another problem is that even if states do enforce strongly on their corporations, some states have a lower interest in space affairs, which could lead to corporations moving to these states in order to be less restricted (Weeden & Chow, 2012). Apart from the previously mentioned possibility for dual-use, the weaponization of space might be further encouraged by the tensions between corporations, which might ask for help from their state and thus create interstate tension. This could be prevented if the Accords had given corporations a more individual status as resource appropriators, which relates to more appropriate and complete boundary setting as per Ostrom's (2015) first design principle. Another possibility to prevent this and also keep states more in line would have been stronger enforcement mechanisms. As discussed previously, the Artemis Accords might not have sufficient enforcement mechanisms to prevent repeated or heavy transgressions if the initial

enforcement mechanism of ‘naming and shaming’ does not succeed. As can be seen with the nuclear proliferation of states in contemporary history, states tend to disregard their diplomatic reputation if their interests in transgressing rules are great enough (Hymans, 2006). These problems of rule enforcement would not have existed if the fifth design principle by Ostrom (2015) had been fulfilled and more severe transgressions could be punished harder. However, resolving this seems unlikely given the current anarchical international system with sovereign states, who are unlikely to agree with stronger enforcement mechanisms that limit their sovereignty (Niou & Ordeshook, 1990).

All in all, it seems that the Artemis Accords may indeed increase the risk of space weaponization, due to both the design of the Accords and the tensions it has caused. This is also related to the violation or incompleteness of design principles, if these principles had been fulfilled, these risk increasing factors of design flaws and increased tension could have been resolved. This also shows that the second hypothesis seems to be partially correct, there indeed seems to be a relationship between the failure of the Accords to fulfil the design principles and risks of weaponization due to the Accords being unable to facilitate trust and cooperation, but this is not the only factor, as ambiguous and incomplete rules also grant possibilities for weaponization.

## Conclusion

As this research has shown, the Artemis Accords does not fulfil all the design principles by Ostrom (2015), which means that it is unlikely to succeed as an institution for sustainable space governance. This is also the answer to the main research question as stated previously, the Artemis Accords do not comply with the third design principle of Ostrom (2015) and cannot fully satisfy the first and fifth design principles because of important shortcomings. This is problematic, not only since it means the Artemis Accords cannot function effectively as an institution for sustainable space governance, but also because of the influence the Artemis Accords have on the weaponization of space. This leads to the follow-up question on the implications of this for space weaponization. As discussed previously, the Artemis Accords have increased tensions between the major spacefaring states, most importantly the USA, PRC and Russia. These tensions increase the risk of weaponization (B. Li, 2020). These increased tensions could have been prevented if the third design principle had been fulfilled, given that there would likely be an increase in trust and cooperation due to the agreement

between the spacefaring states on a new framework of rules. Furthermore, the Artemis Accords have sections that are not complete enough to prevent the weaponization of space. This is due to the fact that corporations and companies do not have a status as separate appropriators in space and due to problems delivering harsh sanctions for severe, repeated transgressions of the rules, which might not be harsh enough to discourage appropriators to not violate rules. These relate directly to the first and fifth design principle by Ostrom (2015), if these principles had been fulfilled these issues of appropriator definition and enforcement would not have existed. Therefore, the Artemis Accords likely increase the risk of space weaponization, due to the tensions it has caused and the incomplete nature of the Accords. Had the Accords sufficiently fulfilled the design principles of Ostrom (2015), both of these issues could have been resolved.

This research has both strengths and weaknesses. A strength of this research is that a deeper analysis of the sections of the Accords themselves can lead to a better understanding of the Accords as its own institution, instead of mostly looking at either one section of the Accords or the political effects the Accords have caused without a detailed analysis of its actual contents. However, when conducting a deep analysis of agreements there exists a risk of personal interpretation that can lead to different, unobjective results, especially if the rules and sections are formulated in an ambiguous manner as with the Accords. Of course, a strong effort has been made to minimize the effects of personal interpretation in order to keep the results and analysis as objective as possible. The results of this research seem to reach similar conclusions as other research on both the tensions caused by the Artemis Accords (Boley & Byers, 2020) and the shortcomings of the Accords to function as an institution for sustainable space governance (Tronchetti & Hao, 2021; Vazhapully, 2020). This signals that the results of this research are unlikely to be heavily influenced by personal interpretation, since its outcomes do not deviate heavily from previous research.

This research can also function as a foundation for future research. A specific analysis on for example the enforcement mechanisms of the Artemis Accords that can go into further detail can help grant new insights in the influence and functionality of the Accords and a better understanding of the Accords as an institution. Apart from this, there are also opportunities to research how specific states, in particular space-capable states and states that count as space users, are influenced by the Accords, given that such analysis is usually limited to important spacefaring states even though space is becoming increasingly more accessible (A. S. Li, 2020). This also counts for corporations and companies, a detailed analysis of how they are

influenced by the Accords could be an interesting future research opportunity. Lastly, a research in the far future could analyse whether the expected influence and effects of the Artemis Accords have come to fruition and whether the Accords have been more or less successful than what contemporary research has concluded thus far.

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