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Security and Space Colonies
Theoretical Frameworks in the Age of New Space

INTRODUCTION

There is an intense debate about space travel among space professionals and some sections of the public. What would be the best approach, the most sensible goal, how should it be funded and which programs should be cut. While this debate may refine some things, the fact remains that the major space powers in 2024 appear to be very committed to establishing permanent outposts or even colonies on other planets and to utilising all the opportunities that space can offer. When talking about space colonies today, the discussion revolves around the Moon, Mars, the mining of space resources and orbital space stations. Occasionally, Venus or the moons of the gas giants are also mentioned, but they usually only exist as concepts and ideas. At the same time, due to geopolitical tensions and the multiplier effect of dual-use space technology, security concerns are becoming more prominent, which is also reflected in the space budget for 2023. According to Euroconsult (2023), government spending on defence-related space projects was higher than for civilian programs, representing a significant shift compared to previous years. This chapter will present some ideas and trends from the fields of security studies and policy to explore how these two disciplines are or could be approaching the expansion into space.

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SECURITY STUDIES AND SPACE COLONISATION

In the fields of security studies, the conflicts that could arise in connection with the colonies can be interpreted based on three different approaches. The realist–neorealist approach assumes that the international field is chaotic, that there is no supreme regulating force and that actors will pursue their own interests and goals, if necessary, ruthlessly and not based on morality. To assume otherwise would be naive and downright dangerous for a state or any actor. Everett C. Dolman's *Astropolitik* applies the realist theory to space activities (Dolman 2001). For a realist, a colony on another celestial body or in outer space would be a logical extension of state power and a new territory to control. Chaotic, rivalry-based relationships would persist in space and could add a new layer to already complex relationships. Establishing colonies is simply an extension of a state's (or corporation's) power, and as long as it does not reach a barrier, it will continue to expand. Realists would probably emphasise the scarcity of resources, securing strategic locations and the importance of preparation for armed conflict.

The liberalist approach to space, as presented for example in Michael Sheehan's book, recognises the existence of rivalry, conflict and the chaotic nature of international relations, but at the same time argues that there are more levels of relations, not just conflict (Sheehan 2007). There are also economic relations, alliances and space law is an important factor in the relations of space powers. Liberalists might argue that the colonisation of space is the result of internal political interactions and that democratic political systems are important for colonies. Conflict between space powers could be avoided, but only if there is trade between them, and the likelihood of conflict decreases if all actors are liberal democracies. Joint projects such as the International Space Station, mining projects carried out by all actors on a celestial body, conflict resolution and mutual aid agreements will be important.

The constructivists would agree with the liberalist thinkers in this regard and might emphasise the importance of the links between actors and that the interaction itself will shape their space activities. As Moltz and some other

experts point out, space, much like the seas and oceans, is seen as celestial pathways connecting different actors, while space settlements would be expressions of national vitality and power (Moltz 2014). The narratives and myths surrounding the activities in space are important in this context because they influence the interaction between the actors.

All three approaches have the merit of pointing out important elements concerning colonies. There are significant risks, opportunities for cooperation and connections that could hold the whole structure together. Various scholars attempt to combine the ideas of these three different approaches and find a middle ground without disregarding any of the components they have identified. An example of such an attempt would be Brad Townsend's book from 2021 (Townsend 2021). A second theoretical approach could be the widely known and used framework developed by Barry Buzan and the Copenhagen School. Instead of focusing only on military issues when it comes to security, a system of interconnected sectors was created to allow for a broader interpretation of security. The original five sectors were: military, political, economic, social and environmental (Buzan et al. 1998). Later, the areas of cyber and human security were added as additional sectors.

The actors concerned with these different aspects of security were originally states. According to Buzan, there are three prerequisites for the existence of a state: 1. an ideological basis, which is usually nationalism; 2. a physical basis (resources, infrastructure, land, people, etc.); 3. an institutional basis (political system and administration) (Stone 2009). Buzan also answers the question of when something becomes a security issue. The concept of securitisation basically states that an issue can become a security issue whenever it is labelled as such. If this act convinces decision-makers, the issue in question is shifted from a purely political area to a security policy framework. Accordingly, the establishment of colonies is already a security problem. Space scientists, politicians, military planners, etc. discuss the possible security aspects of space colonies and initiate projects to counter perceived threats or devise different plans to deal with future problems.

As a comment on the sector-based security framework, the proposal to include space as a new sector in the list could be justified. Space capabilities are so closely intertwined with our way of life today and most of our defence, industrial and economic systems that they have become part of the critical infrastructure, just like the cyber domain. Due to their unique characteristics and requirements, highly specialised knowledge is required to understand what is happening in space. This knowledge and expertise are also essential to guide any kind of space policy, including space security policy.

A THOUGHT EXPERIMENT

Another possibility would be to focus on the different spatial areas where the security of the colonies may be important, or on the benefits that one entity receives from the other. This is already embedded in the interpretation of space security, which could mean three different things at once. Outer space for security:

1. outer space for security: the use of space systems for security and defence purposes
2. security in outer space: the protection of space assets and systems against all types of threats while maintaining sustainable development of space activities
3. security from outer space: protecting human life and the environment of our home planet from natural threats from space (e.g. space weather events, asteroids, etc.)

These different interpretations make the topic of space security a very broad subject (Mayence 2010). But experiments like this not only highlight the different approaches and overlapping areas of space security but can also be used to develop a system that draws attention to parts of a complex system that might otherwise be neglected. Looking at a complex system in a compartmentalised way is a widely used method. The advantage might be the certainty of getting attention, the

disadvantage might be that the tools become a rigid doctrine, that other systems are rejected, or that the links between different areas are disregarded, especially if the responsibility for a particular area is given to one part of an organisation without an effective unifying department. To conduct a thought experiment: In case of establishing a permanent colony, the interpretation and assessment areas of space security could be the following:

1. Outer space for Earth's security: how to use space systems to enhance security and defence on Earth.
2. Outer space for the colony's security: how to use space systems to enhance security and defence for the colony.
3. Security in Earth's outer space: the protection of space assets and systems against all kinds of threats while maintaining sustainable development of space activities close to Earth.
4. Security in the colony's outer space: the protection of space assets and systems against all kinds of threats while maintaining sustainable development of space activities close to the colony.
5. Earth protection: protecting human life and our home planet's environment from natural threats originating from outer space (i.e. space weather events, asteroids, etc.).
6. Colony protection: protection of human life and the colony's environment from natural threats originating from outer space (i.e. space weather events, asteroids, etc.).

The fact that there is no point No. 7 is not a coincidence or an editing error. The system is not complete, several elements are missing. One addition could be the safety of the vast areas between Earth and the celestial body where the colony is located. Also, some of these areas already have known and accepted names, such as No. 5 – planetary protection. This term does not have Earth as a distinguishing adjective in the name because it is not yet necessary. The above system, which focuses primarily on the endpoints, could lead to the area in between being ignored.

Furthermore, there are axioms and assumptions built into this system that can lead to problems later on. A crucial and easily neglected component is the point of view. In this particular experiment, the reference point was the Earth, considered as a whole, while the colony was a single extended entity and not all possible colonies on the planet, so the reference scale could be skewed. The entity conducting the analysis can be a country, an alliance of countries, a corporation, or any mixture of these elements. All of these actors will view the benefits and obstacles in space from their own perspective, and divergent interests can lead to problems. The above framework could be supplemented by a layer of security in the actors' relationships.

Moreover, if Earth is chosen as a point of reference, the underlying ideological assumption could be that the planet can be seen as a unified entity or that the system is an encouragement to unification or a by-product of a desire leading towards that goal. Proponents of space colonisation often assume that colonisation might unite humanity, or that it is only possible if we leave the disputes of the past behind. Viewing the Earth as a single entity has another axiom at its core, namely that it views humanity and the Earth as one. In 2024, this is a valid axiom, but as it is often part of the arguments for space colonisation, the survival of humanity is at stake, so an even higher level of abstraction could be added: the safety of humanity, which may not be the same as Earth. This is of course a very theoretical question, but the idea itself may have some impact.

An unintended consequence of the example in our thought experiment is that the system that treats the Earth or sovereign entity and the colony separately can lead to patterns of thought and assumptions where members of one group begin to think of their own group as more important and view their partner as selfish and oppressive, creating an "us versus them" mentality that leads to conflict. This can happen, even though the oft-cited incident with the Skylab 4 crew, who deliberately turned off their radios and disregarded ground control, apparently did not take place (Uri 2020). Unresolved grievances, especially after a long period, might give potential rivals the opportunity to influence

relations between the two parties and therefore pose a security risk that not only affects the efficiency of the mission.

HISTORICAL AND MILITARY ANALOGIES

After such considerations, we can discuss the use of historical analogies in approaching the complexity of space. As with any as yet unknown terrain, people tend to examine the past and try to draw conclusions and lessons that might be applicable. In case of a permanent human colonisation of space, numerous eras and examples can be used to shed light on one aspect or another of current or likely future events. The Age of Discovery is one of them. The desire for spices drove Europeans to look for alternative routes to India and they landed on a continent previously unknown to them. In the centuries that followed, America changed in a rapid and drastic way that still evokes emotions and triggers debates between different groups in society. The era of colonisation is another example, in which great empires were founded that stretched across the globe, again causing drastic changes.

There are also localised historical events that manifest themselves in the space policies of certain powers. The Wild West and the frontier spirit can be seen in the documents of American space policy. According to the Weinersmiths, recent scientific research shows that the accuracy of this idea is very low and is considered a poor model, not just to explain the way, but also for the future. However, this does not stop many proponents of space colonisation from repeating the narrative that is closely tied to prevailing narratives about U.S. history (Weinersmith–Weinersmith 2024).

In connection with the Age of Discovery and the era of colonialism, it is logical to draw parallels with naval power. Naval strategists such as Alfred Thayer Mahan have often been used as a starting point and even among space lawyers the regulation of sailing rights, fishing rights, etc. serves as inspiration. Metaphors related to the navy are also available, and not just because of the similar terminology (e.g. ship vs. spaceship, etc.). Bowen uses the analogy

of sailing in shallow coastal waters to describe our current space activities (Bowen 2020: 113–115). The comparison does indeed have some merit, with the addition that it was highly dependent on maritime technology. With the development of shipbuilding, navigation and sufficient incentives, seafarers left the coastal waters. This is the same reason why new propulsion technologies are so important, as they can make journeys shorter, easier to supply, safer and cheaper, which are all important factors for space activities. That is why NASA aspires to have thermal and electric nuclear propulsion systems. One such program is the Demonstration Rocket for Agile Cislunar Operations (DRACO) research project. The project will start in 2021 and DARPA has selected General Atomics, Blue Origin and Lockheed Martin. The Department of Defense hopes to be able to perform rapid manoeuvres in cislunar space while taking advantage of the high confidence ratio of chemical propulsion and the high propulsion efficiency of electric systems. The program originally planned to demonstrate the technology in 2025 (DARPA 2021).

There are other expressions coming from the military sphere that are modified but try to emphasise the importance of the colonies. Space and the Moon are sometimes referred to as the ultimate high ground. However, not everyone agrees with the use of this term and might call it simplistic as it only emphasises some general benefits, or it might be misleading and lead to bad practices (Bowen 2022: 25–33). The use of the phrase is perhaps not the most accurate, but could also serve to raise awareness, and when that is achieved, an explanation of the different orbits and other specifications of space can follow. Between the Earth and the Moon, for example, there are Lagrange points (which are rather areas) where a spacecraft can maintain a stable position within the Earth–Moon system with low fuel consumption due to the near balance of gravitational forces. These are natural points to station space stations or observation devices because they are the peaks of the gravitational "landscape", while the Earth and to a much lesser extent the Moon are in a "well" or, to use the geographical metaphor, a valley. Parapet orbits surrounding the entire Earth–Moon system could also offer some advantages for observing the entire system (Wilmer–Bettinger 2022).

A striking difference is that Earth and Mars have no Lagrange points, they do not revolve around a common point of gravity. On the other hand, the Earth–Sun L2 point lies between the orbits of Earth and Mars, just like the Mars–Sun L1 point is. However, due to the different orbital periods, they are of less use. So-called cyclers, orbits that do not keep an object in a relatively static position between Earth and Mars, but allow a close flyby of the two planets at low energy cost, do exist, but their use can only produce limited results. As a result, strategists need to think about the security of a Mars colony very differently from that of a colony on the Moon. The term 'ultimate superiority' will not suffice here.

All of these examples can, to some extent, serve as a warning to do better this time. It is not our aim to make a thorough analysis of all examples, but we can add that they are not just blueprints or warnings, but at the same time tools used in the current political internal or geopolitical debates, revealing a clash of ideologies. Not only do they tell us what the future should look like and thus guide our politics in the present, but the images also reflect on our interpretation of the past and support certain narratives.

THE RIGHT PLACE FOR A COLONY

It goes without saying that the colony's environment is of crucial importance when it comes to any kind of security arrangements and their policies. The main ideas for colonisation focus on the Moon, Mars and sometimes space around the Earth. Space stations are a unique approach because they must be built entirely from materials transported from Earth or perhaps a future mining facility. Planets and moons are a different category, so it is worth exploring the different parameters that could influence a decision process, whether from a technical or political perspective. For comparison, the chart also includes Venus, the planet whose surface is considered particularly hostile to life.

Table 1
Characteristics of the Moon, Mars and Venus

	Moon	Mars	Venus
Distance min.–max. (in million km)	0.363–0.405	55.65–399.58	39.79–259.71
Distance in light seconds and communication delay[1]	1.3	182–1,342	133–869
Frequency of ideal launch window	could be more per day	780 days	584 days
Travel time	3–3.5 days	128–333 days	109–198 days
Orbit period (Earth years)	0.07	1.880	0.615
Length of days (Earth days)	27.3	1.026	−243.018[2]
Size compared to Earth in %	27%	53%	95%
Surface gravity Earth 9.80	16.6%	38%	91%
Atmosphere	n/a	Carbon Dioxide, Nitrogen, Argon	Carbon Dioxide, Nitrogen
Atmosphere effect	n/a	very thin, but dust storms can have an effect	highly corrosive, high pressure
Surface temperature Celsius[3]	−183 to +121	−153 to +20	+464
Surface air pressure (ratio to Earth)	0	0.01	92
Priority ranking	1st	2nd	3rd
First successful soft landing	1966	1971	1970
Human landing	1969	–	–

1. Equal to light seconds depending on the planets' positions. For example, a message sent to Mars could even take 21 minutes to reach the red planet. A reply would take the same time to arrive back to Earth. Mission controls often have one-way light time, two-way light time and distance from Earth displayed on their screens.
2. The −243 refers to Venus rotating clockwise, compared to all the other planets which rotate counter clockwise. And one day on Venus takes appr. 243 Earth days, the slowest rotation speed in the solar system. Interestingly a day on Venus is longer than its year (225 Earth days).
3. The average range of temperature on the equator or mid-latitudes. In certain places temperature could reach −253 degrees Celsius, at other locations, like craters they could be temperate and more stable.

Sources: Compiled by the author based on NASA, ESA and Planetary Society databases.

The table shows average data, but does not take into account minute quantities and is therefore not detailed enough to make precise astronomical predictions. But it shows why, despite its drawbacks, the Moon is a much more tempting and practical target. It is much closer than Venus or Mars and would be an ideal stepping stone and training ground for Mars. Observing the data also makes it clear why Venus is not a viable option for colonisation. Even though it is closer and comparable in size and gravity to Earth, the surface air pressure and corrosive atmosphere make it the least suitable for a permanent human presence.

EARLY MILITARY PLANS FOR THE MOON

The use of other planets, especially the Moon, for defence and military purposes was not unthinkable in the early years of the Cold War. Project A119, also known as the Study on Lunar Research Flights (SECRET), was a U.S. Air Force initiative. The idea was born in 1957 and a team of researchers led by Leonard Reiffel was commissioned to carry out the calculations for the project. Carl Sagan, who participated in the project, revealed its existence in an application for a Miller Fellowship. Reiffel believes that this was a breach of security on Sagan's part because the most important aspect of any such project is their existence (Reiffel 2000). The aim was to demonstrate to the world and the Soviets that the Americans could reach the moon and detonate a nuclear warhead near it and on its surface, creating a clearly visible mushroom cloud. It turned out that there would be no mushroom cloud due to the lack of atmosphere, but the explosion might still have been visible (Armor Research Foundation 1959). The exact reasons which led to the cancellation of the project are still unclear. There might have been worries about the rocket not reaching its destination and falling back on Earth.

Project E4 was the Soviet parallel to A119. E-1 had the mission to hit the moon, which was only achieved with Luna 2 in September 1959. E-2 and E-3 had a similar plan, both were to go around the moon. E-2, like Luna 3, managed to fly around and send back the first images of the far side of the moon, but

E-3 failed to reach orbit. The aim of E-4 was to detonate a nuclear warhead on the surface of our celestial companion. The Soviets even built a mock-up of the spacecraft, but fearing that the payload would fall back onto Soviet territory or impact on foreign soil in the event of an imperfect launch, they scrapped the idea (Zheleznyakov 2009).

Project Horizon was the first plan to use the moon for security purposes. In 1959, the U.S. Army conducted a feasibility study for the establishment of a Lunar Outpost. The original goal was to observe the Soviets, act as a communications relay and perhaps establish a small military outpost. By 1966, there would have been about 12 soldiers at the base, all for USD 6 billion (approximately USD 63.6 billion in 2024) (U.S. Army 1959). The total U.S. budget in 1959 was USD 93.5 billion, therefore it is not surprising that President Eisenhower cancelled the plan. All similar plans got merged with the lunar landing projects or cancelled, especially after the 1967 Outer Space Treaty.

CURRENT PROGRAMS

Today, the main goal is not to build a military observation post on the Moon. The participants in the new projects to other planets intend to establish a permanent presence on the Moon, make the whole endeavour financially and strategically viable, and use the Moon as a base camp for further exploration.

The United States has the most advanced exploration program, a robust space industry with private companies and the largest space budget on Earth. According to Euroconsult, the U.S. space budget was USD 73.2 billion in 2023 (Euroconsult 2023). The U.S. has a lot of experience, plays a major role in the operation of the ISS, has launched numerous successful missions to the Moon and Mars and has the ambitious Artemis program. The Artemis I mission was launched on the 16th of November 2022, and successfully tested the Space Launch System and the Orion spacecraft (U.S. Department of State

2024). At the time of writing this chapter, 36 countries were among the signatories.[2] However, the Artemis Accords ignited debates. Washington received criticism that they turned away from true multilateralism which can lead to fragmentation while at the same time encouraging space resource exploitation without the guarantees of the Moon Agreement (Bartóki-Gönczy – Nagy 2023). Another interesting point is the possible establishment of safety zones, as provided for in Section 11 of the agreement. These zones could be extended and would serve as an instrument to avoid any kind of interference with ongoing operations. It is feared that the safety zones could be the first step towards establishing a military presence on the Moon. In 2022, the U.S. published its National Cislunar Science and Technology Strategy and the Space Force is also paying increased attention to cislunar space and intends to launch ORACLE, a satellite designed to observe and patrol cislunar space, in 2026.

Many European countries have also signed the Artemis Accords while ESA and the EU also make an important contribution to the program, in particular through the European Service Module. Europe is a major player in global space exploration. The national budgets of the EU member states together amount to around USD 10.3 billion. The EU itself has allocated USD 2.8 billion for this purpose. According to the report, the government contribution to ESA, ESO and Eumetsat amounted to USD 6.3 billion, which comes from national sources (Euroconsult 2024). The report does not take into account the entire ESA budget for 2023, which amounts to around USD 7.7 billion. The reason for this is that the ESA budget is made up of ESA member states (66.2%), EU funds (24.2%), Eumetsat (1.8%) and other sources (7.8%) (ESA 2023). There are very high quality and important missions to the Moon and Mars launched by one or the other European organisation, but there is no separate lunar program designed to mimic the objectives of Artemis. The exact role of Europe is not

[2] Angola, Argentina, Australia, Bahrain, Belgium, Brazil, Bulgaria, Canada, Columbia, the Czech Republic, Ecuador, France, Germany, Greece, Iceland, India, Israel, Italy, Japan, Luxemburg, Mexico, the Netherlands, New Zealand, Nigeria, Poland, the Republic of Korea, Romania, Rwanda, Saudi Arabia, Singapore, Spain, Ukraine, the United Arab Emirates, the United Kingdom, the United States of America, Uruguay (15 February 2024).

entirely clear, regarding the costs and the benefits. There were opinions about Europe being treated as a subordinate or a contractor. One of the arguments was that for the money and effort invested, it was not clear when and if Europe could send an astronaut to the Moon (Parsonson 2023). Later in 2023, this issue seemed to have been solved and Europe was promised a place both on Artemis IV and Artemis V (Howell 2023).

The Indian budget amounts to around USD 1.7 billion, while Japan has a budget of USD 4.6 billion. Both countries have a range of valuable expertise and good track records when it comes to missions to the Moon and Mars. Japan's contribution is also very important for the Artemis project or the Lunar Gateway Station. India is rather reserved in this respect but has very successful missions such as the Chandrayaan series. South Korea with its USD 0.7 billion and the United Arab Emirates with its USD 0.3 billion budget are relatively latecomers, but they are ambitious and committed. The list is far from being exhaustive and this brief note does not sufficiently recognise these spacefaring nations. However, they are all more or less aligned, subscribe to the U.S.-led project and there are no significant tensions between these countries to compare with those between China and the U.S.

The People's Republic of China has a space program that is a potential competitor to the American program. Its budget amounted to USD 14.1 billion in 2023 (Euroconsult 2024). However, this is only an estimate due to a lack of sources and transparency. Chinese space activity is characterised by the intertwining of industry, the military and the communist party, making clear data difficult to obtain. Although the budget is not fully accessible, the results speak for themselves. The successful Chang'e missions, especially the Chang'e 4, which landed on the far side of the Moon, brought China international recognition and served as an incentive for Washington to accelerate its own space program. Geopolitical and geographic analogies are used in China as well. A newspaper reported in 2017 that Ye Peijian,[3] the head of the lunar program, compared the Moon to the Diaoyu–Senkaku Islands, which cause tensions

[3] Yè Péijiàn 叶培建.

with Japan as Beijing disputes the islands (Hong 2018). But this is not his first statement along this line, in 2015 he voiced similar opinions.

Strongly connected to their own Chinese Lunar Exploration Program[4] is the International Lunar Research Station[5] partnership launched in 2021. It aims to establish a permanent multi-purpose base on the Moon's surface and after a robotic phase, humans should join to aid the operation of the base as well by 2035. The main partner and founding member of the project was Russia. At the time of writing this paper, 6 other countries joined raising the total number of participants to 8.[6]

Russia, as a partner of the ILRS and a former member of the Lunar Gateway project, is now in a difficult situation. The space budget is USD 3.4 billion in 2023 (Euroconsult 2023), but the state of the space sector is not good. The Luna missions were supposed to be part of the ILRS project, but with the failure of Luna 25, the benefit of Russian participation for China is less than expected and there are serious doubts about the actual Russian capabilities. Russian space expert Asif Siddiqi believes that Russia wants to piggyback on China to get to the Moon because Russia could not do it alone (Times Radio 2023).

To summarise the current trends from a security perspective, all actors interested in colonisation seem to focus on two centres and projects, Artemis and ILRS, led by the U.S. and China. These two groups are not fixed blocs or alliances, but they reflect geopolitical trends to a large extent. The concern that the other side will arrive first and secure the best geographic locations on other planets or establish such a presence that others cannot even enter the area is present in the discussion. However, to describe these efforts as a race is inappropriate. As space policy expert Aaron Bateman put it: "Space race is a misleading characterization because the US and China, for example, are in a sustained competition to develop space capabilities that can enhance their national security aims" (Bateman 2024). The term space implies that it is

[4] Zhōngguó Tànyuè中国探月.

[5] Guójí Yuèqiú Kēyánzhàn国际月球科研站.

[6] China, Russia, Venezuela, South Africa, Azerbaijan, Pakistan, Belarus, Egypt (15 February 2024).

a more short-term challenge with a clear starting point and finish line, which could not be further from the truth if the players want to establish a permanent presence on the Moon and continue expansion into outer space.

SUPPLY AND DESIGN FOR THE COLONIES

Establishing any kind of foothold in space or on planets, a crucial safety issue arises: the question of supplies. The most important goal is that the mission achieves its objectives. If humans are involved in the mission design, they have physiological and psychological needs to stay alive and function well for the mission. At the same time, they should avoid any kind of permanent damage to their quality of life. As we know, people are sometimes willing to perform dangerous or even potentially lethal activities in exchange for a higher salary, but ideally, such risks should be reduced to the minimum. In case of a robotic mission, the need for supplies is different, but still present. Energy sources, building materials, spare parts and the possibility of repairs are just some of the items on the list. A sophisticated system is required to supply the colony with the right quantity and quality at the right time. This serves as a link to the supplier, which can be the colony's sovereign or a third party, e.g. a private company. The supply has an origin point, must have a production location (on Earth or theoretically on a space station, another planet, etc.), a means of transportation, an endpoint where the supplies can be stored or used immediately, and in the background, financing, a political will to supply and a production capacity. However, such connections are also vulnerabilities. In the future, the best method for an opponent might be to set up a blockade to cut off supplies. The more the colony is dependent on this, the greater the risk. Stockpiling key resources, spare parts, etc. could be a short-term solution, but a more effective method would be to produce locally. This would make the colony less vulnerable and more resilient to supply problems, but this in turn also increases the ability to become independent, which may not be in the interests of the colony's ruler.

Ensuring that the colony is well-supplied and self-sustaining to a desired degree begins in the planning phase. For the sake of argument, we will use another naval analogy and consider the first colony as a nuclear submarine in combat. Both operate with a highly skilled crew in environments where humans could not survive. The colony, with its confined spaces, must be tightly sealed off from the outside world and ensure that nothing from the outside can penetrate the habitat or affect the inhabitants, be it radiation, gasses or the vacuum of space. Oxygen is a limited resource in both places, just like food, drinking water and other goods. Supplies can only be replenished at infrequent intervals. They might be too far away for any rescue team to reach them in time, so they must be able to operate independently. The energy source for the colonies may be a nuclear reactor, therefore the design must also consider the rules of nuclear safety. Of course, there are differences here too. The colony cannot travel, it would be much further away and in more inhospitable environments than any submarine ever was, but could expand its facilities over time. But a key principle for submarine design also applies to the security of space colonies: security by design.

For complex systems that include life support, mission-specific equipment, energy resources, etc., security should be a goal at the outset, even if not all relevant parts have been added or fully built. The answer to the question of whether or not a newly established space colony should have defence from the start is no. The reasons for this are numerous: cost efficiency, a matter of priorities, the absence of a threat, etc. Installing any kind of weapons on a lunar base would violate the Outer Space Treaty, trigger diplomatic conflicts and lead to an arms race on other planets. However, security requirements could be added at the design stage so that if a base needs to be expanded, the designated space, additional energy generation capacity, etc. is already in place. This could be a signal to other space powers that in the event of a conflict these elements can be added without there being an actual threat. It can be argued that the potential rival would respond in the same way on a different basis, and assumptions about differing levels of readiness in the perception of the other

side may still lead to a downward spiral arising from an unfolding security dilemma for the participants.

One solution to this dilemma could be the seemingly opposite approach to preparedness, namely the absence of any security and defence considerations. This could be the initial phase for all colony projects, as the establishment of a functioning life support system, living quarters, laboratories, etc. is necessary to even begin operations. If this lack is the result of disregarding possible future problems, then it is not a sign of peaceful intentions, but rather of negligence or wilful blindness. However, if this is done as a strategy to keep the threat perception of potential rivals low, coupled with an agreement made in advance and a reliable verification system to ensure they hold up their end of the bargain, this could be a viable strategy.

PAYING THE BILL

Part of the discussion is a familiar line of argument for any kind of space activity. Why spend money on it, we should rather spend it here on Earth. Space activities for the sake of exploration are only undertaken by adventurers, but all the great explorers of the past were funded by governments hoping for trade, but there is no trading partner in space, so the benefits seem rather subjective (Schiller 2009). One justification often cited by proponents of space colonisation is that every dollar spent on space is actually spent here on Earth, funding companies, securing jobs, etc., while having a multiplier effect and encouraging innovation. There are additional benefits from the extraction of resources. It will not solve any problems on Earth, but the minerals mined on the Moon or from asteroids would be used to expand space infrastructure rather than using rockets to put material into orbit. According to Carlson, the Chinese space program was able to integrate such plans and ideas into its space program earlier than the U.S. (Carlson 2020: 68–86). Certain trace elements such as helium-3 on the Moon could represent an enormous new source of energy.

But even a mission to the Moon is expensive. There are different calculations as to how much it would cost to keep a small team of astronauts on the Moon. Older estimates vary between USD 10 and 36 billion (Anderson 2019). By comparison, the Biden Administration's proposed NASA budget for 2024 is USD 27.2 billion. Congress could only approve about USD 25 billion for 2024 and 2025, but the Artemis project is a priority (NASA 2024). The final amount will depend on launch costs and the technologies that enable the production of oxygen, food, water, fuel and construction materials on site, but it will not be cheap. Regardless of the amount, there are opinions even among space experts that overemphasising the Moon from a security perspective is misguided. To quote Aaron Bateman: "From a military standpoint, the moon is not a strategic piece of territory. In the near future, the moon will likely be a place of limited scientific research. I think that the heavy focus on the moon and cis-lunar space are misguided and that the focus should be on the way in which space systems are linked to terrestrial political, economic, etc. goals" (Bateman 2024).

The logical response to space dollars being spent on Earth is that if they spent those amounts on anything else, they would be reflected here on Earth in salaries for other professions, etc. This debate has to do with moral values, worldviews, threat perceptions, economic interests and many other factors. Perhaps it is not too far-fetched to say that at this stage we do not know what results the attempt to colonise space could bring, and we can consider it a ground-breaking new research project. It requires large investments, the outcome is uncertain, but there is hope for potential benefits on a large scale.

DISCUSSION IN SOCIETY

Space policy makers and defence experts are not the only ones debating space expansion and the best approaches to it. Governments communicate in one way or another about space programs. There are specific methods and goals for each country. In the U.S., there is a lot of talk about the space race, which is an

imprecise term, but it can serve to generate enthusiasm for the space program, create a sense of urgency and perseverance, and at the same time create the impression of another historical era in which the Americans triumphed and won the space race against the Soviet Union. In China, the communication is different, it is more to strengthen the legitimacy of the communist government, to boost national pride and to show the world that China is no longer a backward nation. In general, Chinese space-related communication methods are linked to communist propaganda techniques while utilising the most sophisticated IT tools and relying on the higher receptivity and willingness of the population for political action (Edl 2022).

In parallel to government communications, academics, public figures, celebrities, various ideological groups and the general public also participate in the discussion. The use of words and phrases is a highly observable aspect of the conversation. The term colony itself can spark political debates. It needs to be the subject of another paper to fully explore the ramifications of the various terms and their use in current political debates. As a brief introduction to the topic, the main ideas seem to revolve around the historical phenomenon of colonisation, when Western, mostly European powers occupied territories and used their resources to strengthen their own economies, warfare capabilities, etc. The establishment of space colonies is often referred to as a possible return of colonisation, as it could be that spacefaring nations use the acquired resources to further strengthen their power and dominate world politics even more, instead of sharing everything (Giri 2022).

The word exploitation is also a peculiar word in many respects. It often has negative connotations, especially when it describes the relationship between people. Yet, in terms of resource extraction, however, the word describes the phase in which the discovered mineral deposits can be extracted and used. In his book, Carlson describes the phases of space colonisation as: Exploration, Expansion, Exploitation and Exclusion. In his opinion, the key to the whole endeavour lies in the third phase of exploitation, which will make the whole endeavour financially worthwhile. Any space power that makes this transition will have a far superior space program and will have great advantages in space and therefore on Earth

as well (Carlson 2020: 174–213). The mutual observation of the space powers will further boost their activities in space because they do not want to be left behind. At present, the government bears most of the expenses in the exploration phase, which could create a commercial market after a while. This would be a reason for manned bases on other planets, because it might be more expensive to supply bases with human inhabitants, but at the same time the constant high revenues can attract private companies, which make services cheaper, which in turn attracts more people to the colonies, and so on and so forth. This hope is shared by most proponents of space colonies. More cautious opinions warn against getting too excited because they do not see a possible transition from exploration to exploitation and we should rather focus on sustainable mining on Earth (Segura-Salazar – Moore 2023). Others suggest we should not even try and the whole capitalistic approach is wrong because it will damage the space environment.

There is no room in this paper for a thorough analysis of the discussion on "colonies" or "exploitation". As an aside, avoiding the word colony because of historical connotations may prove insufficient to ensure that a similar event does not occur in the future. Any word can be used to describe, justify or cover up malicious intentions and actions. A painfully obvious memento of this is the word freedom. Even if the extraction of resources were not accompanied by territorial claims, there is no guarantee that the resources will not be used to feed a military-industrial complex. Refraining from asserting property rights may also mean that one does not take responsibility for damage or pollution at the site. Conversely, one could argue that precisely because of the risk of aggression and domination, the word colony should be retained as a reminder and warning that the whole process could once again become a pawn in great power politics.

INDEPENDENCE FROM THE VIEWPOINT OF SECURITY

Debates about the future of humanity and space colonies often touch on the question of the ideal political system. The relationship between the established player and the colony is a key component of this. A colony declaring independence is a possibility far in the future. It is not only an ideological question, but also a question of security and defence. There are proposals for independent, self-governing societies from the beginning. The idea sounds nice, but even if the founder and investor do not exercise control, the supply dependencies mentioned earlier can make the new colony highly dependent on other actors. For colonies with an owner or heavy dependency, the tantalising historical parallel would be the American War of Independence or any colony becoming independent. For such an event to occur, a number of conditions must be met. To revisit Buzan's idea of a state and the conditions for its existence, we could build on this idea, modifying and extending it to encompass the case of colonies gaining and maintaining their independence.

- The ideological basis: In case of the colonies, they must have the idea that they are a distinctive community, different from any kind of nation or the Earth itself. How the process of establishing this idea plays out and what the unifying idea would be, depends on many factors, could take the form of a smaller community, similar to a city (creating an independent space polis to use the analogy to the Greek city states), a country, or it could expand to all colonies on the given planet, so the unifying idea would not be nationalism, but rather "planetism". Even a dichotomy with Earth and all colonies outside Earth is a theoretical possibility.
- The drive: When we talk about gaining independence, we must add another element to the ideological foundation. A strong identity is not enough to start any kind of movement for self-government, because the prevailing idea could be to remain under the rule of the current sovereign, because of external threats, good relations, etc. The conviction that independence is achievable and more beneficial than the status quo is

paramount to all such aspirations. This conviction does not have to be fully accepted by the population, it is sufficient if the people who can control the colony share this idea. As a complementary requirement, there must be a conviction in the existing controlling faction that it is better to grant this independence than to try to prevent it in any way. This is not necessarily the result of an armed struggle. It is possible to achieve this through political action.

- The physical basis: A colony must have a sufficient number of qualified people, various types of facilities, economic capacity and the necessary physical infrastructure to sustain life. Depending on the celestial body hosting the colony, this may mean things that are not an issue on Earth, such as oxygen, radiation protection, etc. In this category we also need to include tools and capabilities to gain and maintain independence against internal or external threats.
- The institutional basis: In order to be able to govern itself, the new institution must establish and maintain its administration and institutions. In most cases, this would not mean the destruction of the previous systems; at least some elements would be preserved.

A special case of independence would be unintentional, de facto independence, when the original sovereign is unable or unwilling to exercise control over the colony. This must be the case until the colony has reached a point where it wishes to, and is able to, maintain its independence. One argument often made by space travel advocates who want to establish settlements on other planets is that this could very well happen if something were to happen to our home planet. An asteroid could hit Earth, there could be a catastrophic nuclear war, or in case of a solar activity, there could be a global collapse of the technosphere. Pelton even mentions the weakening of Earth's magnetosphere due to a magnetic polar reversal; this could mean that global civilisation is more vulnerable than previously thought (Pelton 2021: 138). The main idea is that a sufficiently developed and self-sustaining society on another celestial body would increase the chances of survival of the entire human

race, it could be a seed for restoration, so that we must become a multi-planet species (Cuthbertson 2021). This alone would not be a sufficient argument to justify all expenditure on such efforts, but it can influence general opinion, have an emotional impact on individuals and strengthen the motivation of people trying to achieve this goal.

CONCLUSIONS

This chapter has presented frameworks and analogies for discussing security issues adapted to activities in space, more specifically to the establishment of colonies on other planets. Focusing on the Moon and using it as a step towards Mars projects has a good rationale and the space powers seem to be pursuing this direction while avoiding falling into a disadvantageous position vis-à-vis their geopolitical rivals. There is disagreement over priorities, approaches or even the use of certain words, on the assumption that avoiding certain words could help prevent the recurrence of similar events in the past. Geographical, historical or military concepts are often used to prepare for the unknown future, and they have their merits and limitations. Theoretical research and the creation of new frameworks will continue in order to avoid possible obstacles and problems. The expansion of widely used systems could also prove useful. This includes the inclusion of space as a new sector in the security sector framework created by Barry Buzan and the Copenhagen School. Aside from strictly security-oriented assessments, a discourse analysis of the connections between the use of terminology, various historical narratives, political ideology and psychological factors could further enhance understanding in this area and provide some viable alternatives as the construction of other celestial bodies begins.

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