Effective and Adaptive Governance for a Lunar Ecosystem

Lunar Governance Report

Approved and adopted by SGAC

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SPACE GENERATION
ADVISORY COUNCIL

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In support of the United Nations Programme on Space Applications
c/o European Space Policy Institute (ESPI), Schwarzenbergplatz 6, Vienna A-1030, AUSTRIA
www.spacegeneration.org/eagle, eagle@spacegeneration.org, + 41 1718111830

The Action Team on Effective and Adaptive Governance for a Lunar Ecosystem (E.A.G.L.E. Team) was established in June 2020 by the Space Generation Advisory Council (SGAC) to provide the inputs of the young generations for the peaceful and sustainable development of the Moon. In furtherance of this mandate, the E.A.G.L.E. Team developed the present Report, a related Executive Summary and a Lunar Manifesto. These documents have been officially endorsed by SGAC and consequently submitted as conference room papers at the 60th Session of the Legal Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS).

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Ad luna!
The SGAC Eagles

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E.A.G.L.E. TEAM MEMBERS

Name	Nationality	Background
Antonino Salmeri (Lead/Editor)	Italy	Law & Policy
Nuria Ali	Kenya	Geology
Ghaida Aloumi	Saudi Arabia	Literature
Amelia Batcha	USA	Aerospace Engineering
Erwan Beauvois	France	Systems Engineering
Erin Gibbons	Canada	Earth and Planetary Sciences
Mclee Kerolle	USA	Law & Policy
Martin Losekamm	Germany	Aerospace Engineering
Carlos Mariscal	Mexico	Computer Engineering
Mariam Naseem	Canada/ Pakistan	Engineering, Business
Paolo Pino	Italy	Systems Engineering
Giuliana Rotola	Italy	Law & Policy
Mehak Sarang	USA	Strategy, Physics
Jenna Tiwana	UK	Business, Aerospace Engineering

LIST OF ABBREVIATIONS

AA - Artemis Accords

ARRA - Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space

BB - Building Blocks

CSA - Canadian Space Agency

E.A.G.L.E. - Effective and Adaptive Governance for a Lunar Ecosystem

ECLSS - Environmental Control and Life Support System

ESA - European Space Agency

IETF - Internet Engineering Task Force

ISAS - Institute of Space and Astronautical Science

ISRU - In-Situ Resource Utilization

ISS - International Space Station

JAXA - Japanese Aerospace Exploration Agency

LEO - Low Earth Orbit

LIAB - Convention on International Liability for Damage Caused by Space Objects

LTS - Long-term Sustainability

MA - Moon Agreement

MVA - Moon Village Association

NASA - National Aeronautics and Space Administration

OLF - Open Lunar Foundation

OSI - Outer Space Institute

OST - Outer Space Treaty

PCA - Permanent Court of Arbitration

SGAC - Space Generation Advisory Council

SWIP - Solar Wind Implanted Particles

UNCOPUOS - United Nations Committee On Peaceful Uses of Outer Space

USA - United States of America

USSR - Union of Soviet Socialist Republics

OVERVIEW OF THE MAIN FINDINGS

This Report provides the ideas and proposals of the young generations for a governance regime that can ensure the peaceful and sustainable development of the Earth's Moon. Based upon a comprehensive assessment of the lunar policy landscape, it aims to foster convergence among global actors for the development of common guidelines and norms of behaviour for lunar activities. The paragraphs below summarise the Report's main findings. Anyone interested in a condensed version of this Report is encouraged to read the accompanying Executive Summary as well as the EAGLE Manifesto.

Section 1 introduces the importance of lunar governance for the future of space activities. To this end, it articulates the four criteria that should shape its development according to the young generations: fairness, effectiveness, adaptiveness and sustainability. First, a lunar governance regime should guarantee safe access to, and shared enjoyment of, the exploration and use of the Moon as the province of all humankind. Second, a lunar governance regime should achieve these goals through stable decision-making processes and fast implementing procedures. Third, a lunar governance regime should connect these regulatory elements with the results of in-situ learning, incrementally evolving hand in hand with our knowledge of the lunar environment and experience with operations thereby. Fourth and finally, a lunar governance regime should pay due regard to the interests of future generations, preserving and enhancing their parallel right to explore and use the Moon.

Section 2 of the Report provides a thorough overview of the current lunar policy landscape. Section 2.1 considers technological firsts for lunar exploration and finds that its historical progression has evolved in harmony with the rules of space law. For what concerns our present, the section highlights areas or resources possessing intrinsic scientific, strategic and commercial value (water and other volatiles, metals, solar illumination, and radio-quiet areas), which are at the roots of the recent acceleration in lunar policy developments.

Section 2.2 analyses these developments, including the Artemis Accords and documents produced by groups like the Hague Working Group, the Moon Village Association, the Open Lunar Foundation, the Space Treaty Project, and others, to identify shared ground and contentious issues around lunar policy developments. The Section finds seven points of general agreement and five contentious aspects, with three overarching topics standing in between consensus and contention: multilateralism, registration and space resources. Ultimately, the Section finds that proposed policies tend more to agree than disagree, and where there is disagreement, this seems to be primarily caused by a lack of clear understanding of the "adversary" positions.

Section 2.3 presents an analysis of the needs and priorities of the global space community. These findings have been developed based on a series of interviews conducted by the E.A.G.L.E. Team between September 2020 and February 2021 with 21 stakeholders representing the various segments and interests of the global space community. Based on the overall analysis, the Section presents the following five key global priorities (listed in no hierarchical order): international harmonisation (in support of adaptive governance); inclusive and transparent negotiations (in support of legitimate governance);

multi-stakeholder discussions (in support of effective governance); public/private partnerships and technical integration (in support of a lunar economy). This list of five global priorities is permeated by sustainability as an overarching trend recognised as utmostly defining in the design of laws, technologies and missions.

Section 3 of the Report outlines the proposal of the young generations for a way forward. Driven by adaptiveness and inclusiveness, this proposal is focused on the development of a sharable narrative, as captured by a new international instrument: a Lunar Governance Charter. Section 3.1 finds that a charter may be the type of legal instrument needed at this point in international space diplomacy. With this term the Section refers to a legal document enacted to define the essential features and boundaries of a legal framework through the solemn commitment of its signatories. Historically, charters fit in a time where technology and economic development constantly progresses at a rapid rate, like the present one. Conceptually, charters encapsulate a general but coherent approach to the regulation of a given topic, like the one needed now. Finally, charters have a flexible legal nature: they can either be binding or non-binding, depending on the intentions driving their processes. Broadening the discourse initiated already in various policy documents, a Lunar Governance Charter can consolidate existing consensus and further clarify current misunderstandings. Framed in these terms, a Lunar Governance Charter can constitute a shared reference framework for the incremental development of inclusive lunar regulation.

Section 3.2 presents 12 fundamental topics that the Team suggests to include in a Charter. A Lunar Governance Charter should begin by restating the fundamental rules of international space law as well as the guiding principles shaping the development of the way forward. Following, the Section presents ten aspects that should be addressed in the Charter: inclusiveness, interoperability, human life protection, heritage preservation, balancing needs, use of lunar resources, safety zones, registration and liability, minimum coordination and conflict resolution. Section 3.3 complements the proposal by providing two procedural considerations for the development of the Charter. To this end, the Section recognises UNCOPUOS as the primary forum for the negotiation of a Lunar Governance Charter. At the same time, the global significance of the Moon requires a multi-stakeholder process drawing from the various perspectives of all humanity. Therefore, the Section suggests that UNCOPUOS find appropriate ways to receive and implement inputs from global society.

The fourth and final section of the Report concludes with the aspirations of the Eagles. Mindful of the benefits of plurality, the E.A.G.L.E. Team would like for its voice to help synchronise all the others, turning the current cacophony into an harmonious choir. With this Report, the Team hopes to respark the bright flame that has lit the best years of international space law, for the development of a lunar legal framework that can honour the exploration and use of the Moon as the province of all humankind. The E.A.G.L.E. Team calls the whole space community to action to seal a global, intergenerational, and multistakeholder pact for the regulation of lunar activities under a shared narrative of peace, inclusiveness, prosperity and sustainability.

1. INTRODUCTION

A new era of lunar exploration is upon us. For the past 50 years, inspired and emboldened by the incredible feats of the Apollo era, humanity has developed a new and sophisticated understanding of Earth's only natural satellite. Through a suite of missions to the lunar surface and its vicinity, discoveries of resource deposits in the lunar regolith and ice traps at the poles, among other features, have transformed our conception of humanity's future on the Moon. All the while, terrestrially, the space industry has been undergoing dramatic transformations. Private actors and nations worldwide with newly developed spacefaring capabilities have set their sights on returning to the Moon. What will come of this new era of lunar exploration, in terms of scientific and commercial returns, remains to be seen.

The last 50 years of space exploration have yielded important lessons regarding space governance. The global nature of space required new modes of governance to coordinate activities that transcended borders. At the dawn of the space age, a new multilateral forum, the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS), emerged to coordinate the development of international space law. Due to the wide range of stakeholders and activities in Earth's orbit, UNCOPUOS was progressively joined by dedicated regulatory bodies, such as the International Telecommunications Union. Thanks to the efforts of these bodies, space activities have flourished, with thousands of satellites providing critical infrastructures for nearly every citizen on Earth.

This new era of lunar exploration, with a range of new actors operating in the harsh lunar environment and potentially competing for the same set of limited resources, will surface novel governance challenges. The existing governance regimes, however, are necessarily limited to the environment they were primarily designed for – the Earth's orbit. Coordinating activities on the surface of a celestial body and ensuring the sustainable use of its resources are unprecedented endeavours that will require the development of innovative regulatory tools. None of the existing governance regimes is well-suited to address the unique challenges associated with extending our range of activities to the lunar surface. Thus, there is a clear need to establish a dedicated and global governance framework for the Moon.

In the early stages of lunar activities, the primary purpose of this governance regime should be to enable coordination and cooperation for the peaceful and sustainable exploration of the Moon. As plans turn to actions, lunar actors need guidance and assurance that any proposed infrastructure or activities would not only be permitted, but also safe from harmful interference. To this end, it is essential to develop common guidelines and norms of behaviour as well as mechanisms to ensure their respect by all lunar actors. As representatives of the young generations, we believe that a lunar governance regime should be based on four components: fairness, effectiveness, adaptiveness and sustainability.

Fair governance ensures appropriate consideration of the needs and instances of all stakeholders, irrespective of their degree of economic or technological development. A fair lunar governance regime should guarantee safe access to, and shared enjoyment of, the exploration and use of the Moon as the province of all humankind.

Effective governance is measured by its ability to conduct public affairs and manage public resources. An effective governance regime should have an established decision-making process and implement the results of that decision-making process. These features are essential to realise the promise of lunar 'resources', broadly understood beyond minerals and volatiles as landing sites, special orbits and unique areas on the surface. Only the effective management of these resources will ensure the sustainable development of the Moon. And without a smooth process for handling harmful interferences, lunar activities will quickly descend into chaos.

Adaptive governance regimes manage systems particularly susceptible to high amounts of uncertainty and risk, fostering a culture of learning to evolve as new information is discovered. An adaptive governance regime acknowledges information gaps and establishes networks to enable coordination between actors, building in feedback loops and resilience. On the Moon, there can be no effective governance without prior in-situ learning. There remain too many unknowns with regards to lunar surface features and operations to develop a comprehensive set of standards and regulations. As such, an adaptive governance regime is particularly well-suited for the exploration and use of the Moon.

Sustainable governance preserves and enables the conduct of activities across generations. Sustainable lunar governance upholds the right of all actors, present and future, to the exploration and use of the Moon by promoting its technologic and economic development in harmony with the unique features of its environment. We believe that sustainable lunar governance should guide the development of the Moon as an ecosystem: a circular environment where all humanity can thrive in peace.

Lunar governance should be based on the principle of subsidiarity. Hierarchical, top-down governance structures may prove to be less useful as capabilities for lunar spaceflight, exploration, and settlement will likely be distributed among a variety of actors around the world. An effective and adaptive governance regime acknowledges and reflects this reality, and looks ahead to the unknown equipped with the right mechanisms to learn and continue to adapt to reflect new realities and values. When Buzz Aldrin became the second human to set foot on the Moon on July 24th, 1969, making him one of the few humans to bear witness to the lunar surface, he characterised it as "magnificent desolation." There was, according to him, "no place on earth as desolate ... because I realised what I was looking at, towards the horizon and in every direction, had not changed in hundreds, thousands of years."

No longer will the Moon be a desolate environment. As humanity further ventures throughout the solar system, the Moon is likely to see a flurry of activity. How we choose to establish the governance regime for this new era is as critical as the rules that it will include. The Moon is humanity's only natural satellite. Therefore, we must ensure that all actors, present and future, can have shared and assured access to its exploration and use, while protecting the unique features of its environment. The only way to do this is if we develop the Moon as an ecosystem: a circular environment where all humanity can thrive in peace. The Moon is just the beginning, a springboard for our future interplanetary society. Developing an effective and adaptive governance for the Moon will, in the words of the evergreen Outer Space Treaty, enable us to preserve and enhance the exploration and use of space as the

province of all humankind. Undoubtedly, this is one of the most difficult challenges in the history of humanity. But it is one that we intend to win.

Space Generation Advisory Council (SGAC) is the largest network of students and young professionals in the space industry. SGAC was conceived at UNISPACE III in 1999, whereby States resolved, as part of the Vienna Declaration, "to create a council to support the United Nations Committee on the Peaceful Uses of Outer Space, through raising awareness and exchange of fresh ideas by youth. Its vision is to employ the creativity and vigour of youth in advancing humanity through the peaceful uses of outer space".

In pursuance of this vision, SGAC recently entered the global debate on lunar governance to provide the perspective of the young generations on this crucial topic for the future of humanity. To this end, it established an action team focused on Effective and Adaptive Governance for a Lunar Ecosystem - the E.A.G.L.E. Team - consisting of 14 scientists, engineers, lawyers, policy analysts, and more, with representation from 10 countries. Built upon a genuine understanding of the value of cooperation and coordination across borders, the diversity of our Team reflects our desire for international coordination.

We wish to catalyse multilateral discussions, and ensure that lunar exploration will include, benefit, and inspire citizens from all around the world. We also represent a generation that has a fundamentally different understanding and experience with space exploration. Our generation has grown up under the auspices of almost permanent human occupation of low-Earth orbit with the International Space Station. We have also been inspired by the feats of entrepreneurs such as Elon Musk, and the promising potential of the NewSpace industry. Our generation will be the scientists, policymakers, engineers, and entrepreneurs of this new era of space exploration. Not only are we ready for a new governance regime, but we will also be the ones living and working under its rules.

Plans for lunar governance abound. Over the course of a year, the E.A.G.L.E Team met with stakeholders across national space agencies, private industry, and non-governmental organisations, to stitch together the viewpoints and proposals of these various groups. We have perceived a widespread attitude towards broader multilateral discussions and integration of national and international frameworks. Topics like safety zones, resource utilisation, and coordination mechanisms are intensely debated and deserve peculiar efforts. Most of all, we have learned that these equilibria are dynamic and constantly changing. We need to build bridges among different or contentious instances, and we need to build bridges that can be stretched, branched, remodelled, adapted. We need tools that can keep the pace with the fast-growing technical progress, consolidate the existing baselines and bring clarity to grey areas.

This Report aims to foster convergence among global actors involved in lunar governance. To this end, it has been developed taking into account all the available inputs and viewpoints that have been brought to our attention. These elements are discussed in Section 2, which provides an overview of the *status quo* for the conduct and regulation of lunar activities. To begin with, the section presents historical precedents as well as current plans for the exploration and use of the Moon. Building upon this factual assessment, the section moves

to consider current policy developments for the regulation of lunar activities, highlighting areas of shared ground and contention. Finally, section 2 concludes by discussing global priorities and needs for lunar governance, as observed during the interviews conducted by the E.A.G.L.E. Team between September 2020 and February 2021.

We conclude our Report proposing the global development of a Lunar Governance Charter. Throughout history, the development of international space law has followed an invisible but consistent 20-years path. Over the last sixty years, this path has seen three cycles, each with its specific narrative: the treaties (1960 - 1980), the principles (1980 - 2000) and the guidelines (2000 - 2020). We recently passed the 20-year mark, but we are still struggling to find our new narrative. Having carefully observed the status quo, we believe that the next twenty years could be the time of charters. These are general and coherent documents providing a shared starting point for the harmonious development of incremental regulation. As such, charters are flexible instruments fostering convergence without hindering diversity. Building upon the conducted assessment of the status quo, section 3 presents the idea of a Lunar Governance Charter. Importantly, the section does not lay down the charter in itself. We believe this task naturally belongs to UNCOPUOS as the multilateral forum for the development of international law. At the same time, we felt the responsibility of motivating our proposal with substantive and procedural recommendations for a Lunar Governance Charter. Hopefully, our suggestions will be useful in enabling the multilateral process and multi-stakeholder dialogue that should characterise the enactment of this foundational document. Ultimately, we hope that our proposal can help to seal a global, intergenerational, and multistakeholder pact for the exploration and use of the Moon under a shared narrative of peace, inclusiveness, prosperity and sustainability.

Anyone interested in a condensed version of this Report is encouraged to read the accompanying Executive Summary as well as the EAGLE Manifesto.

2. THE STATUS QUO

This section provides an overview of the *status quo* for the conduct and regulation of lunar activities. To begin with, Section 2.1 considers technological firsts for lunar exploration, together with their legal and policy implications, as well as the current technical realities behind the renewed global interest in lunar exploration. Following, Section 2.2 analyses current policy proposals for lunar governance to identify shared ground and contentious issues within the lunar legal and policy landscape. Finally, Section 2.3 presents the needs and priorities of the global space community based on 21 interviews conducted by the E.A.G.L.E. Team between September 2020 and February 2021.

2.1 Historical Precedents and New Realities for Lunar Exploration

This Section considers technological firsts for lunar exploration, together with their legal and policy implications, as well as the current technical realities behind the renewed global interest in lunar exploration.

2.1.1. The Three Eras of Lunar Exploration

The Moon has captured society's imagination for millennia, yet only in modern times has humanity visited this beautiful but desolate body. Since 1958, there have been over 130 missions to the Moon, both robotic and crewed, including flybys, landers and impactors. From our viewpoint, the history of lunar missions can be divided into three relatively distinct periods: the Apollo-Luna Era, the Resurgence of Publicly-Funded Science Missions, and the Advent of Commercial Activities.

The *Apollo-Luna Era (1959-1978)* was shaped by the USSR and USA through the great-power rivalry that defined the Cold War and the Space Race. Although both nations were guided by political objectives rather than scientific interests, this period of frantic activity laid down the foundation for many technological, legal, and scientific advancements of the subsequent decades. Next, the *Resurgence of Publicly-Funded Science Missions (1990-2019)* gained momentum after a nearly 20-year hiatus where no missions left Earth for its natural satellite. After the Space Race favoured the USA and attention from the superpowers drew elsewhere, interest in the Moon waned until Japan's ISAS launched their first lunar probe, Hiten. This was quickly followed by a new mission from the USA (Geotail) and then by a series of firsts achieved by incoming players from Europe, China and India. With the crash of Israeli SpaceIL's Beresheet lander into the lunar surface in 2019, the *Advent of Commercial Activities (2019-Present)* has begun. This third and current era is fueled by an increasing commercial interest beyond governmental plans. A plethora of publicly and commercially funded missions are thus planned throughout the current decade, aiming to establish necessary knowledge for a long-term human presence on the Moon. Figure 1 identifies national participation in lunar activity related to time, where lightly coloured bars indicate failed missions.

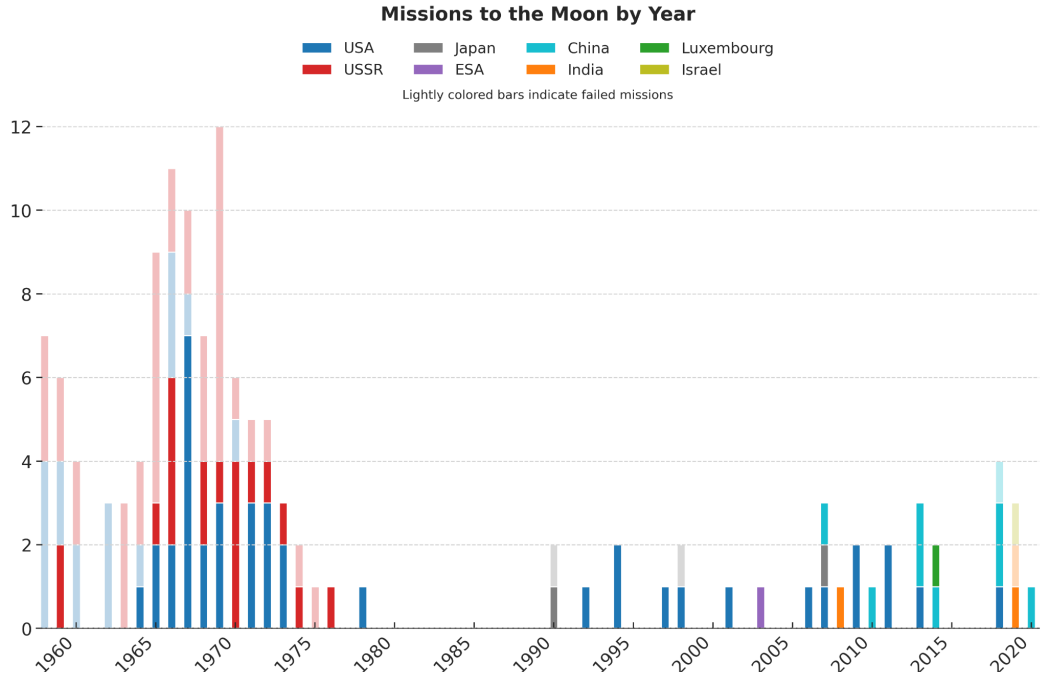

Figure 1. Missions to the Moon by year and by Nation. Lightly coloured bars indicate failed missions.

Trailblazing missions achieving technological firsts have been accompanied by important legal implications. The historical progression of lunar activity has evolved in parallel with the development of international space law, mutually reinforcing each other through the following series of technological firsts.

2.1.1.1. First Space Object on the Lunar Surface *(12 September 1959)*

The first space object to reach the lunar surface was the Luna 2 impactor probe, the sixth spacecraft of the Soviet Union's Luna program. It was the first spacecraft ever to reach the surface of a celestial body other than Earth. Luna 2 was purposefully impacted ~30 degrees North of the centre of the Moon's visible disc to obtain particular data of interest. The probe carried radiation sensors and magnetometers consisting of two spherical pennants, each engraved with the State Emblem of the Soviet Union. The pennants contained explosive devices designed to shatter them after they were released by the probe to distribute them across a wide area on the lunar surface. With Luna 2, the USSR became the first State to establish its right to place an object on a celestial body without the explicit consent of another State. At the same time, Soviet scientists notified astronomer Bernard Lovell at the University of Manchester of the exact time of the predicted impact, to ensure that the West would verify their claim of success independently.

2.1.1.2. First Non-Functional Object Left on the Lunar Surface *(12 September 1959)*

Luna 2 was also the first artefact left by humanity on the surface of another celestial body. In light of the obvious difficulties for the Soviet Union to retrieve the probe's remains at the time, the mission contributed to the global acceptance of leaving non-functional space

objects on the surfaces of celestial bodies, potentially remaining there for hundreds if not thousands of years.

2.1.1.3. First Spacecraft to Orbit the Moon *(31 March 1966)*

The USSR was also the first State to successfully place an artificial satellite in orbit around the Moon. The Luna 10 satellite entered orbit on 3 April 1966 and carried a broad range of scientific instruments for studying the Moon's magnetic field, the composition of the lunar surface, the interplanetary radiation environment, and the micrometeoroid density. For political publicity, the probe also carried a recording of "The Internationale", a transmission of which mission controllers played for the 23rd Congress of the Communist Party of the Soviet Union. With the placement of Luna 10 in lunar orbit, the USSR became the first State exercising the right to freely explore celestial bodies under the 1963 Declaration of Legal Principles. The Luna 10 case exemplified how exploration missions could be used for public engagement, and it was seminal for the consolidation of the 1963 Declaration in the soon to be enacted Outer Space Treaty.

2.1.1.4. First Terrestrial Organisms to Travel to the Moon *(14 September 1968)*

The Soviet Zond 5 spacecraft was the first to carry life from Earth to the Moon and successfully retrieved these terrestrial organisms back to Earth alive. Though the ballistic re-entry of the spacecraft would have been lethal for humans, the two tortoises, as well as the fruit flies and plants aboard, survived and were successfully recovered from the reentry capsule after its unplanned splashdown in the Indian Ocean. This displayed proof of concept that living organisms could survive lunar missions and reentry.

2.1.1.5. First Crewed Mission to the Moon *(21 December 1968)*

The first crewed spacecraft to leave Earth orbit and fly around the Moon was Apollo 8. The US spacecraft left Earth on 21 December 1968 and entered orbit around the Moon on 24 December 1968. Although the USSR put the first human in space which lasted 108 minutes, Apollo 8 displayed a successful 6-day mission with the technical capability to manoeuvre humans around a celestial body. Albeit technically similar to the Soviet's Zond 5 mission, Apollo 8 actually marked the beginning of humanity's journey into deep space.

2.1.1.6. First Crewed Landing on the Moon *(16 July 1969)*

The most significant achievement within this series of firsts is obviously the successful Moon landing of the Apollo 11 astronauts Neil Armstrong and Buzz Aldrin on 20 July 1969. Armstrong and Aldrin spent less than a day on the lunar surface collecting samples for scientific analysis. The Apollo 11 descent stage was fitted with a plaque bearing the inscription: "Here men from the planet Earth first set foot upon the Moon July 1969, A.D. We came in peace for all mankind." By choosing not to stress their American nationality but rather their belonging to the human species, the Apollo astronauts sent the message that anyone travelling in space represents all of humanity. This was the first application of the

principle that *the exploration and use of space shall be the province of all humankind*, a defining moment in the neverending process for inclusive and peaceful space activities.

2.1.1.7. First Samples from the Lunar Surface *(16 July 1969)*

The Apollo 11 astronauts collected and brought to Earth more than 25 kg of lunar soil and rocks, marking the first human interaction with space resources. Though primarily intended for scientific purposes, the Apollo 11 mission set an important precedent in favour of the right to extract and use space resources under Article I OST. One year later, this practice was subsequently upheld by the USSR with the Luna 16 mission, which returned to Earth a small sample of 101 grams taken from the Mare Fecunditatis.

2.1.1.8. First Spacecraft to Soft-Land on the Far Side of the Moon *(7 December 2018)*

China's Chang'e 4 lander touched down in the South Pole-Aitken basin on the far side of the Moon on 3 January 2019. This mission demonstrated the first soft landing on the far side of the Moon as well as the possibility of sending communications thereby. This technological first is especially important in light of Article 22.22 of the Radio Regulations of the International Telecommunication Union, which prohibits emissions causing harmful interference to radio astronomy observations and to other users of passive services in the "shielded zone of the Moon". This zone is defined by Article 22.22.1 as the area of the Moon's surface and an adjacent volume of space which are shielded from emissions originating within a distance of 100 000 km from the centre of the Earth.

2.1.1.9. First Commercial Spacecraft on the Lunar Surface *(21 February 2019)*

Beresheet was the first non-governmental mission as well as the first ride-share mission to the lunar surface. Even though it did not manage to land on the lunar surface safely, the Beresheet lander of the Israeli company SpaceIL established an important precedent when it crashed into the Moon on 11 April 2019. Scientists were concerned because a capsule of tardigrades in a natural cryptobiotic state carried by the lander had the potential to spread tardigrades on the lunar surface. Although it was ultimately concluded that there is little danger of this occurring, the Beresheet mission sparked discussion as the first commercial spacecraft to potentially biologically contaminate a planetary surface.

2.1.1.10. Debris and Inactive Objects on Lunar Surface

Six decades of lunar exploration have left their mark on the lunar surface, mostly in the form of dozens of inactive landers, rovers, and debris from intentional and unintentional crash locations, in addition to the equipment left behind the six Apollo landing sites. The total mass of human-made objects exceeds 200 tons, of which a significant portion has no useful purpose on the lunar surface. Within LEO, unwanted orbiters, rocket stages, or other nonoperational machinery would be disposed of in the Earth's atmosphere. Since this option is not available on the Moon, it will be important to design different mitigation strategies.

Some objects on the lunar surface relative to the Apollo-Luna Era have been identified as potential historic preservation sites by the non profit organisation named For All Moonkind.

Historic protection allows reflection on elements of cultural, social, economic, political, and archaeological antiquity. Protecting humanity's initial imprints on another world provides a snapshot into the past that marked the birth of lunar exploration. From a scientific perspective, many lunar historic sites are still active as there are significant biological and physical data associated with long-term exposure of the lunar environment on human-created systems. These discoveries could educate and inform the design of future lunar missions.

2.1.2. Areas and Resources of Interest for Lunar Exploration

Many lunar surface regions possess intrinsic scientific, strategic and commercial value. Currently, areas or resources of interest include water and other volatiles, metals, solar illumination, and radio-quiet areas.

2.1.2.1. Water and other Volatiles

Water is arguably the most critical resource in cis-lunar space. If potable, it can be used in its liquid form. Further, it can also be split into its constituents, hydrogen and oxygen, to provide breathable oxygen for the crew or elements for rocket fuel. Exploiting deposits of water ice in cis-lunar space, either on the Moon or from asteroids, will be crucial to establish a sustainable human presence on the Moon by decreasing the quantities supplied from Earth. Reserves of water ice have a high probability of existing in the permanently shadowed regions at the lunar poles. However, there is little data on these deposits. Based on analysis gathered by the Lunar Prospector (Feldman et al. 1998) and LCROSS (Colaprete et al. 2010) missions, Crawford estimates that the uppermost meter of permanently shadowed regolith could hold as much as 2.9 billion tons of water (Crawford 2015). If proven to exist, such vast deposits could support future polar missions by considerably reducing the mass of supplies and fuel required from Earth. The scientifically interesting sites located far from the poles, however, could not be quickly supplied by these polar deposits (Flahaut et al. 2012); the establishment of a base would therefore be facilitated by other forms of water ice reserves. Several missions have intriguing data that indicates there may be a presence of water in non-polar regions that are not in permanent shadow (Spudis et al. 2010, Clark 2009). Anand et al. argue that these deposits' practical value remains to be determined (Anand et al. 2012). Therefore, it is likely that missions to establish a long-term presence on the Moon will initially focus on the polar regions.

2.1.2.2. Metals and other Resources

The lunar surface is abundant in unconsolidated regolith, a layer of rocks and fine-grained particles with a thickness of up to 20 meters (Lucey et al. 2006). These particles have been formed by billions of years of micrometeoroid impacts and subsequent weathering by the solar wind and thermal cycling. The regolith contains a number of minerals, the most abundant being plagioclase, pyroxene, olivine, ilmenite, and spinel, but also native metals such as iron and nickel (Anand et al. 2012). Their abundances vary enormously and at times over short distances, though a pronounced general distinction can be made between the basaltic terrains of the lunar mare and the older and more pristine highland regions, which

are thought to be the Moon's original crust (Haskin et al. 1993). The same chemical processes used to extract oxygen from regolith could also be used to produce iron, aluminium, and titanium, which have abundances of up to 17%, 18%, and 8% by weight, respectively (Crawford 2015). Lomax et al. (2020) recently demonstrated the simultaneous extraction of oxygen and metal alloys from regolith simulants. Silicon is also very abundant at a mass fraction of about 20% and could be necessary for the future in-situ production of solar cells (Crawford 2015). The most easily exploitable resource on the Moon may be solar-wind implanted particles (SWIPs). Due to the absence of an atmosphere and a magnetosphere, the solar wind and cosmic radiation directly impinge on the lunar surface. Analyses of Apollo samples have shown that the regolith efficiently retains such implanted ions and can be degassed by moderate heating to temperatures well below 1000 degrees (Fegley and Swindle 1993). The most abundant volatiles are hydrogen, nitrogen, carbon, and helium, which serve many functions. For example, these elements can be used as fuel, reducing agents for the extraction of metals, buffer gas for breathable air, and various other aspects of initial lunar exploration reconnaissance missions (Crawford 2015). Their abundances, however, are generally low and practical use for ISRU thus requires further investigation (Anand et al. 2012). Since SWIP retention is largely temperature-dependent, higher concentrations may occur at higher latitudes in regions that have not been sampled by Apollo (Starukhina 2006).

2.1.2.3. Helium-3

The scientific and non-scientific literature has repeatedly claimed that the Moon may be an abundant source of helium-3, which could be used to power nuclear fusion reactors to produce electrical power. This, however, is most likely not the case. Analyses of samples have shown that the average abundance of helium-3 is about four parts per billion by mass (Crawford 2015). It also exhibits a very non-uniform distribution, with the highest concentrations occurring in the titanium-rich mare basalts. Therefore, the economic value of helium-3 extraction from lunar regolith is rather low, considering the cost of withdrawal.

2.1.2.4. Solar Illumination

Electrical power is one of the essential resources for any mission to the lunar surface. Since the Moon is tidally locked to Earth, a lunar day lasts approximately two weeks, followed by an estimated two weeks of darkness. This causes difficulty generating power with solar cells, which is technically challenging and therefore significantly constrains the spacecraft's capability to perform on the lunar surface. Countries proficient in the use of nuclear power can attempt to mitigate this constraint. There are very few areas at the lunar poles (commonly referred to as the 'Peaks of Eternal Light') that are almost always illuminated, allowing continuous operations using solar power, though they are not necessarily situated close to interesting areas in terms of resources or scientific interest. It is nevertheless conceivable that these areas become contested by those seeking to establish a permanent (crewed or uncrewed) base on the Moon. Elvis et al. (2015) argue that this extreme scarcity makes for an interesting case from a legal perspective, although this scenario is likely of

academic nature only. The actual areas with high illumination are extremely small, and most of them are located on virtually inaccessible crater rims and ridges.

2.1.2.5. Radio-quiet Areas

Several radio astronomers have made the case for building telescope arrays sensitive to extremely faint signals on the far side of the Moon. Such telescopes cannot be built on Earth or Earth orbit because human technology constantly emits radio waves that drown out these tiny signals. Therefore, the far side of the Moon is a unique radio-quiet area in the vicinity of Earth. As seen, the preservation of the radio-quiet areas is ensured by Article 22.22 of the Radio Regulations. At the same time, the technical challenges related to this preservation require enhanced coordination due to the related impacts on mission design.

2.1.3. From Technical Realities to Policy Developments

This section has examined the history as well as the new realities behind lunar exploration. While the Apollo-Luna era has laid down the foundations for humanity's journey into space, expanding our presence beyond Earth could enable a new era of sustainable and efficient space exploration. In the course of this process, the Moon will play a key role both as a testing ground and an outpost for deep space operations. The unique features and advantages offered by the Moon have surged a global interest in its exploration and use for scientific investigations, crewed exploration missions and, potentially, future commercial operations. As a result, lunar policy developments have greatly accelerated, with the goal to operationalise the rules of international space law. Based on the findings developed in this section, the next one will move to analyse these proposals to identify shared ground and contentious issues within the lunar legal and policy landscape.

2.2 The Lunar Policy Landscape

In recent years, lunar policy developments have greatly accelerated as a result of humanity's renewed interest in lunar exploration. At the forefront of this interest stand countries like the USA, which aims to establish a sustainable presence on the Moon in collaboration with commercial and international partners within the Artemis Program framework, as well as Russia and China, which have recently announced their partnership for the development of an International Lunar Research Station. To operationalise the rules of international space law within the framework of the program, in October 2020, a coalition of 8 Countries including Australia, Canada, Italy, Japan, Luxembourg, the United Arab Emirates, the United Kingdom and the United States of America presented a multilateral document called the Artemis Accords. In essence, the Accords are a political commitment towards certain "Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets and Asteroids for Peaceful Purposes". In parallel to the development of the Accords and building upon the successful experience of The Hague International Space Resources Governance Working Group, various actors from the international space community have also released their policy proposals. This section analyses these proposals to identify shared ground and contentious issues within the lunar legal and policy landscape. In addition to applicable norms from international space law, the section's analysis is based upon the following

documents: the Building Blocks of The Hague Working Group, the Best Practices for Sustainable Lunar Activities of the Moon Village Association, the Lunar Resources Policy and the Space Tenure of the Open Lunar Foundation, the Model Implementation of Agreement of the Space Treaty Project and finally the Artemis Accords.

2.2.1. Shared Ground among Lunar Policy Developments

Our analysis of the lunar policy landscape as identified above has highlighted seven topics on which existing policy proposals seem to generally align. In this section we highlight some of the critical takeaways that could help further refining this shared ground and ultimately turning it into global consensus.

2.2.1.1. The Importance of Multilateralism

From our analysis, multilateralism emerges as the process through which multiple countries cooperate and coordinate for the pursuit of common goals. Framed in these terms, multilateralism has been the driving force behind the Outer Space Treaty and the general development of international space law. Moving forward, this sentiment is crucial to the future of lunar governance because, at its core, multilateralism is international cooperation. In the international space community, we found a recurring theme for the support of multilateral discussions regarding lunar governance and space resource activities. Combining the various positions analysed, these multilateral discussions should be guided by the principle of adaptive governance and aim to achieve sustainability and inclusiveness. To complement these negotiations, actors involved at the operational level should develop a series of recommended practices ensuring the safety of activities in the early stages of lunar exploration. Finally, both these processes should involve the global space community at large through open consultations and recognise the importance of plurality with an emphasis on subsidiarity.

2.2.1.2. The Need for Heritage Protection

Historic preservation holds a foundational need that allows reflection on elements of cultural, social, economic, political, and archaeological antiquity. Protecting humanity's initial imprints on another world provides a snapshot into the past that marked the birth of lunar exploration. From a scientific perspective, many lunar historic sites are still active as there are significant biological and physical data associated with long-term exposure of the lunar environment on human-created systems. These discoveries could educate and inform the design of future lunar missions. The cultural value of the Moon is an irreplaceable source of inspiration, and protecting lunar sites of humanity's initial imprint will inspire generations to return to the Moon. The importance of heritage protection is emphasised in all the policy documents examined within our analysis. As a consequence, there is consensus on the need to develop mechanisms for the international recognition and protection of sites and objects bearing significant scientific, cultural or historical interest.

2.2.1.3. The Registration of Lunar Objects

All actors agree that lunar objects should be registered under the Registration Convention. This is universally perceived as a fundamental precondition for the peaceful exploration and use of the Moon. At the same time, all policy developments recognise that the current registration system has been primarily designed for orbital activities and needs to be adapted to address surface operations on another celestial body better. To this end, actors further agree on the importance of providing minimum information on the general location of lunar objects, the nature of the activity in which it is involved, and its intended duration. In parallel to the registration of objects, forward-thinking policy proposals underline the need to register activities and resources further. These additional registries could receive further voluntary information beyond those provided under international space law, with the goal of fostering coordination. However, registration of lunar activities at the moment does not enjoy the same level of agreement reached for the registration of lunar objects.

2.2.1.4. The Importance of Benefit Sharing

All actors agree that space exploration is not a matter of nations but a matter of species. Space is a source of inspiration, promoting the development of the best that humanity has to offer. However, it is a fact that not all nations have the same experience and resources, either financial, scientific or infrastructural, to individually engage in space activities on their own. Although space is considered an asset available to all humankind, only a few actors possess the capabilities actually to access it. At the same time, billions of people on the planet benefit every day from the results of space activities.

As humanity prepares for returning to the Moon, the general consensus is that lunar exploration cannot be conducted as an individual effort. The key words to do so are openness and inclusiveness. All policy developments recognise the importance of sharing information as a critical benefit facilitating international cooperation and inclusiveness in lunar activities. This could be done within a publicly available international database collecting scientific information, discoveries and lessons learnt, and practices resulted from Moon's exploration. In addition to information, we have identified general and operational mechanisms to share the benefits of lunar activities that have the agreement of the involved actors. At a general level, we found the development of space science and technology, together with the active engagement of lunar actors in education and training activities. At the operational level, we recognised the promotion of interoperability and the development of joint ventures fostering participation in lunar activities of all interested countries.

2.2.1.5. The Need for Dispute Settlement Mechanisms

Another area of agreement among the examined policy documents is the need for internationally agreed dispute settlement procedures. The current lack of coordination mechanisms for lunar activities, coupled with the various competing interests involved in the exploration and use of the Moon, create a severe risk of political and economic conflicts. This risk further increases when considering the technical difficulties associated with lunar activities and gets even more problematic in light of the importance that the Moon plays for

our society. Unfortunately, international space law does not provide effective dispute resolution mechanisms to address these potential conflicts. In this respect, all actors agree that this lack of legal remedies contributes to a climate of legal uncertainty discouraging economic investments and potentially threatening the peaceful uses of the Moon. From our analysis, international arbitration has emerged as a potentially agreeable mechanism in light of its flexibility, discretion and equal treatment of public and private parties.

2.2.1.6. The Role of Space Resources

All actors recognise the fundamental importance of space resources for the sustainable development of the Moon. In this respect, we found universal agreement on the need to conduct space resource activities in accordance with applicable international law and, in particular, the Outer Space Treaty. In general, all actors further agree that parties risking their capitals for the exploration of the Moon should be allowed to use its resources reasonably.

All the examined policy documents recognise that space resource activities do not inherently constitute national appropriation of celestial bodies or of their underlying territories. As it will be seen in the next sub-section, proposed policies need further convergence on the development of regulatory mechanisms to govern the extraction and use of lunar resources. At present, the examined documents all affirm that sustainability aspects and commercial interests will need to be balanced in order to enable the full potential of space mining.

2.2.1.7. The Development of Interoperable Standards and Infrastructure

All policy proposals agree on the importance of fostering international coordination and integration among scientists and engineers for the development of compatible, safe and effective hardware and services. To this end, the concept of interoperability is emerging as highly instrumental for the integration of complementary endeavours from different lunar actors. The significant complexity and high costs associated with the development of a lunar base, whether governmental or commercial, could be reduced through the development of interoperable architectures integrating and distributing functionalities. Moreover, it is generally agreed that the use of interoperable standards and infrastructure could significantly reduce the risks for conflict around lunar activities. Further, sharing common knowledge on the practical application of standards among lunar actors would provide invaluable insights for the continuing improvement of systems and infrastructure. Finally, standards are also universally considered beneficial to market dynamics and ecosystem growth, especially for the safe and sustainable use of lunar resources by all interested parties, irrespective of their degree of economic or scientific development. In this respect, all policy proposals agree on the usefulness of an international registry or database for such standards and recommended practices.

2.2.2. Contentious Issues in Lunar Policy Developments

To complement our analysis on the shared ground, we have also identified five contentious aspects in the development of lunar policies. Some of these contested points derive from the continuation of discussions where a reasonable degree of shared ground is already in

place, as in the case of lunar registries. In other cases, as for safety zones, brand new areas for discussion have been opened by the novel challenges of lunar exploration.

2.2.2.1. Structure and Scope of a Lunar Governance Regime

While all policy documents and actors agree on multilateralism as a general approach, exact governance regimes continue to be an area of contention. Determining the level of bindingness and the scope of a multilateral framework for lunar activities continues to be an area of discussion. On the one hand, some documents call for the development of a comprehensive set of binding rules at the international level as a better safeguard for fairness, inclusiveness and sustainability. On the other one, further documents based on the principles of subsidiarity and adaptive governance promote a bottom-up approach to develop more effective regulation. Finally, while all documents agree that any governance regime for lunar activities should take into account the interests of all parties and include contributions from multistakeholder fora, there is disagreement concerning the processes through which the desired level of inclusiveness can be achieved.

2.2.2.2. The Registration of Activities

As discussed in 2.2.1.3, all documents concur on the fundamental importance of the registration of lunar objects. In addition to this, some innovative policies propose the development of similar mechanisms for the "registration" of lunar activities. Due to the novelty of the idea, at the moment, further discussions are needed as to the goals, scope and procedures for this new practice. Some documents explicitly call for the development of a dedicated international registry to centralise information and ensure international coordination. Others prefer to rely on national registries to avoid creating new bureaucracies and allow for the inclusion of private entities. Finally, further discussions are needed to develop consensus on the types of information that should be required in these registries.

2.2.2.3. Resource Rights

While the fundamental role of space resources for sustainable lunar exploration is unquestioned, mechanisms for the determination and allocation of resource rights remain highly controversial topics. Needless to say, the Moon Agreement (MA) remains an important point of contention. On the one hand, the low level of ratifications is pointed out as a reason to sideline the agreement and move forward with new instruments. On the other hand, parties concerned about the inclusiveness and fairness of lunar activities feel reassured by the concept of the Moon as the common heritage of humankind and would like to secure a similar level of legal protection for the interests of humanity at large. The debate on the MA is also connected to the role that should be played by commercial entities in the use of lunar resources. On the one hand, various policies underline the fundamental contribution that private partners can give for the sustainable development of the Moon and the establishment of a flourishing economy thereby. On the other hand, other policies would like to control the risk of monopolisation and uncontrolled exploitation that could arise from the involvement of commercial actors. To reconcile these views, forward-thinking proposals suggest a broad and flexible concept of lunar resources taking into account the interests of

pioneering operators as well as of humanity at large. According to these views, the regulation of lunar resources should allow for the commercialisation of abundant lunar resources while also offering adequate protection to unique natural areas and scarce assets. To this end, these policies rely on plural property rights and a flexible concept of lunar resources that evolves over time based on technological and economic realities.

2.2.2.4 Role of Safety Zones

Safety zones are perhaps the most contentious topics across various policy proposals for lunar governance. From our analysis, we found that this is first and foremost due to the lack of shared understanding as to what safety zones actually are and what purpose do they serve. Documents proposing the concept of safety zones intend it as a coordination mechanism operationalising the principles of due regard and consultation laid down in Article IX OST. However, critiques of safety zones are mostly worried about consequences on the principle of free access under Article I OST and the prohibition of non-appropriation under Article II OST. These two positions are only in apparent contradiction with one another, and thus we believe they will be reconciled as soon as the parties have the opportunity to mutually clarify their views. Further points for discussion focus on the process for the designation of a safety zone, including the level of reviews required, as well as their classifications and their extent, both in physical and temporal dimensions. In this respect, we noted that proposed policies seem to agree that the legal effects of a safety zone should be adjusted depending on the type of activity involved and that safety zones could play a role in the assessment of fault under Article III of the Liability Convention.

2.2.2.5 Modes of Coordination

While all proposed policies underline the need for coordination, there still is a significant level of disagreement as to how actors shall coordinate. Some entities believe that coordination among lunar activities should be overseen by an international body and point either to UNCOPUOS or the ITU. Others respond that while actors should notify the international community about their planned lunar activities, coordination needs to happen on a case by case basis, as mandated by Article IX OST. These divisions are once again caused by different understandings as to the scope and goal of lunar coordination. Policies proposing international oversight are mostly worried about the management of scarce resources and the protection of unique cultural and scientific sites. On the other hand, documents prioritising case-by-case coordination are mostly guided by safety and security concerns. Then again, these two positions are not mutually exclusive and thus, we believe that they could be harmonised by properly differentiating the types of coordination and incrementally implement them as lunar activities evolve.

2.2.3. From Policies to Priorities

From the analysis of these documents, three overarching topics arose both as shared ground and contentious issues. First and foremost, while all actors praise the importance of multilateralism, they do not seem to agree on what should be the way forward to pursue it. Another topic on the verge between consensus and contention is the registration of lunar

objects and activities. Even though it is widely regarded that lunar objects should be registered under the Registration Convention, parties are divided as to the creation of a dedicated registry for lunar activities, the kind of activities that should be included there, and what entity should maintain it. Finally, another critical area raising contradictory reactions is the use of space resources. Although it is generally recognised that sustainable space exploration inevitably relies on *in situ* resources utilisation, there is debate as to how exactly this endeavour should be regulated, especially in view of its commercialisation.

The debate on lunar governance has only recently begun, so the lack of a clear demarcation line between shared grounds and contentious issues is perfectly normal. In this respect, our analysis revealed that there are more elements of agreement rather than disagreement. Where there is disagreement, this seems to be primarily caused by a lack of clear understanding of the "adversary" positions, which means that appropriate clarifications may prove to be significantly beneficial. To this end, the next section will complement and conclude our analysis on the status quo for lunar governance by presenting the results of the interviews conducted by the E.A.G.L.E. Team between September 2020 and February 2021.

2.3. Global Priorities and Needs for Lunar Governance

To conclude the analysis on the status quo, this section presents the needs and priorities of the global space community beyond what has been proposed in existing policy documents. These findings have been developed based on a series of interviews conducted by the Team between September 2020 and February 2021 with 21 stakeholders representing the various segments and interests of the global space community. These interviews have been essential in developing our position in harmony with identified consensus and contention points, and they are a unique feature of this Report.

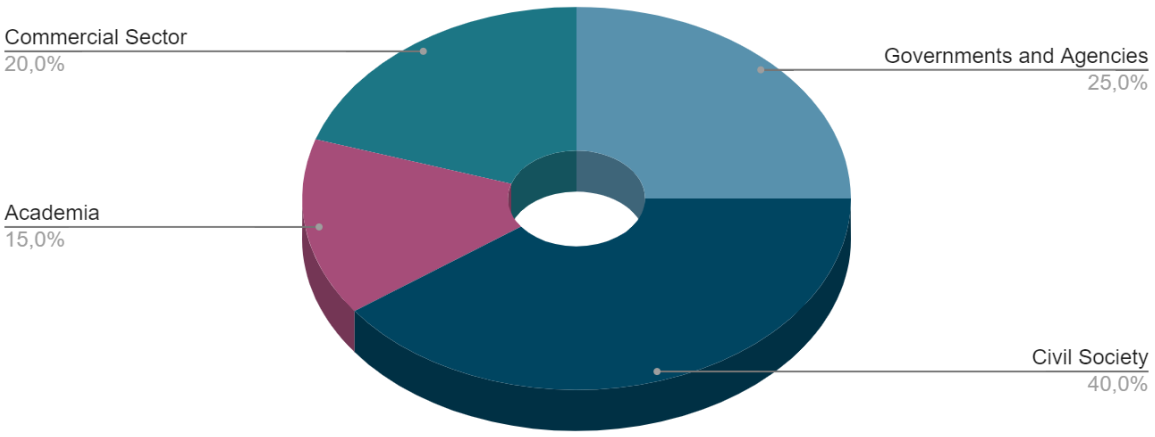

Figure 2. Breakdown of the interviewed stakeholders by category

2.3.1. The Needs of Lunar Governance

As global actors formalise plans to establish a sustained lunar presence, we are at a critical point in time to shape how such a presence should be governed. Given that we are still learning about our Moon and the lunar environment's limited scientific understanding, legal instruments cannot excessively anticipate activities whose consequences are still mostly unknown. However, too much indecisiveness combined with a lack of minimum proactiveness may very well become the primary cause of unsustainable and potentially unethical future uses of the Moon. The current landscape of lunar governance is still rather fragmented. At the moment, States are aligning their lunar governance preferences within the context of specific programmes, like Artemis, or treaties, like the MA. From our interviews, we noticed that lunar actors are rather unsatisfied by the current status quo. To ensure that our Moon remains a resource that all humans can continue to marvel at, we need to introduce a governance structure that all actors can subscribe to - one that can accommodate the needs of pioneers without sacrificing those of all humankind.

Whilst space is free for exploration and use by all States, historically some nations have been more active than others for several reasons, ranging from economic feasibility to a more terrestrial focus for their investments. Nevertheless, it is important that we do our utmost to ensure that the exploration and use of space remain the province of all humankind. In this respect, an inclusive lunar governance structure is required to avoid that current non-space faring nations may be prevented from their legitimate opportunity to fulfil their lunar ambitions in the future. A globally endorsed lunar governance system is also imperative to ensure that a healthy lunar economy is established for both public and private actors. Achieving this high level of recognition could unlock the full potential of the Moon for the benefit of both scientific and commercial communities, ensuring they can operate in harmony and with confidence.

2.3.2. Global Priorities

Within this Report, the expression *"global priorities"* has a twofold meaning: on the one hand, it relates to space as the ultimate endeavour of the human species, which shall be inclusive and global; on the other one, it is a call to responsibility directed at all the entities and organisations populating our planet: cooperating today is essential to explore tomorrow.

The extensive survey of the numerous stakeholders involved in lunar governance and their needs produced a vast landscape of instances and needs. We have identified patterns and trends in this plethora of plans and projections that reflect space actors' current taxonomy and interests. This led us to identify global priorities to be addressed for the peaceful and successful establishment of a lunar governance system.

During our interviews, the development of a lunar economy has been constantly underlined as an essential component of sustainable lunar activities. As is well known, financial resources and compelling business cases are essential elements in the success of a company. These are, in turn, essentially dependent on the existence of solid market demand. For space - and particularly for the Moon - this demand is mainly driven by governments and

agencies. However, this results in relatively small, closed and poorly growing markets. To address these issues, we have found that lunar companies may benefit from more robust integration with terrestrial industries and markets. In the meantime, a greater in-space demand for products and services should be fostered with the enabling support of the public sector. Complementarily, decreasing profit's risks and timelines will be essential to ultimately attract new private investors. As part of this process, clearer regulation on the possibilities of commercial lunar activities could provide certainty, protection and support to those companies willing to engage in the extraction, distribution and utilisation of lunar resources.

This is where governments and space agencies come into play. These entities could and should provide better support to non-governmental lunar activities. From our interviews, public institutions are eager to act as catalysts for the growth of a stable lunar economy, as this will be a vital component for the sustainable continuation of national and international space programs. More interaction with privates and among agencies is therefore needed to provide guidance and improve funding practices. The multi-stakeholder development of global standards and shared and interoperable infrastructures can prove to be a valid step forward in this direction. Related to this, governments should steer the evolution of international equilibria for lunar activities towards the development of an environment shaped by legal certainty and reliable enforcement mechanisms.

Adding the academic perspective into the equation, we have turned our attention to the potentially harmful and detrimental consequences of poor regulation and coordination at the international level. To this end, the economic development of the Moon should not come at the expense of the peaceful uses of space, nor to the detriment of fundamental scientific investigations. From the perspective of academia, the need for balanced solutions is underlined as more important than the need for *any* solution.

2.3.2.1. Key Global Priorities

From our analysis, we distilled the following list of five key global priorities, listed in no hierarchical order, encompassing those brought forth by the interviewed actors and those emerging from our analysis of the Status Quo at the international level.

1. **International harmonisation is the key to adaptive governance.**
   This priority refers to the development of a middle-level framework that could guide the application of the OST principles to lunar activities and enable the development of adaptive governance. Amongst other things, this framework should formalise agreed mechanisms for coordination and dispute resolution and guide the practical determination of fault. This would enable international coordination among operators, enhance shared exploration among partners and provide sound guidance to companies.

2. **Inclusive and transparent negotiations are vital for legitimate governance.**
   This priority underscores the importance of inclusive and open diplomatic negotiations conducted with due regard to the interests of all States. In particular, this should be complemented by appropriate safeguards protecting the needs of those actors who may

be less vocal, like scientists and non-spacefaring States. This is a fundamental condition to provide lunar governance with an adequate level of democratic legitimacy.

3. **Multi-stakeholder discussions are crucial for effective governance.**
   This priority reveals the added value of complementing diplomatic negotiations with contributions from a plurality of actors across the segments of the global society. This would significantly increase the effectiveness of the governance system thanks to the integration of multiple instances and expertise.

4. **Public/private partnerships will be an essential component of a lunar economy.**
   This priority refers to public entities supporting private lunar enterprises in developing robust business cases that can attract private financial investments. Importantly, governmental funding should be complemented by dedicated measures to promote deeper integration with Earth's economy and industries. Bootstrapping a private lunar economy would democratise access to the Moon and reduce pressure upon States.

5. **Technical aspects are just as critical as legal and policy developments.**
   This priority underlines the critical role that can be played by technical integration and cooperation for the establishment of a thriving lunar ecosystem. First, the development of shared standards, interoperable systems and common infrastructure as the cornerstones of future lunar architectures could be a game-changer for international cooperation. Second, the advancement of technical discussions with regards to landing operations, power generation, allocation of frequencies and orbital slots, as well as definition of disposal/salvage protocols may be critical for international coordination.

This list of five global priorities is permeated by an overarching trend that we recognised as utmostly defining: sustainability. There can't be any positive future on the Moon without this element, which must play a central role in the design of laws, technologies and missions.

2.3.3. Where Do We Go From Here

The need for effective and adaptive lunar governance will only strengthen with time. At the end of our analysis, we see the need to balance conflicting priorities stemming from various regional nuances, commercial ambitions, scientific needs and sustainable development. Achieving this balance will not be easy, but for sure it will be worth it. To this end, we believe that all actors should always keep in mind the interests and needs of future generations. During our interviews, this need as well as the work of the E.A.G.L.E. Team has been greeted with great enthusiasm. Above all, much emphasis has been placed on the fact that as representatives of the new generations, we have the possibility and the responsibility to express our perspectives on the development of lunar governance. We are grateful for this possibility and intend to live up to the associated responsibility.

The next section of this Report includes our proposal for a way forward. We hope it can contribute to the early solutioning of what a lunar governance landscape could look like, acknowledging that it will naturally evolve as human presence further expands on the Moon. To this end, our proposal embraces cultural differences and the diverse ambitions of humanity in space. Driven by these values, we realised that what we really wanted to achieve

was convergence. Therefore, rather than crafting a dry list of fixed recommendations, we decided to focus on the development of a sharable narrative. After long reflection, we believe this narrative could be captured by a new legal instrument: a Lunar Governance Charter.

3. THE WAY FORWARD

This section outlines our proposal for the global development of a Lunar Governance Charter. To begin with, Section 3.1 presents the reasons why a Charter could be the type of legal instrument needed at this point in international space diplomacy. Consistently with the analysis conducted throughout this Report, our proposal for a Lunar Governance Charter is not conceived as a finished product, but rather as the beginning of it. At the same time, we felt the responsibility of accompanying it with some substantive and procedural suggestions to help frame the development of multi-stakeholder dialogue. To this end, Section 3.2 addresses ten fundamental topics that we believe should be included in the Charter, while Section 3.3 provides two fundamental procedural considerations for its development.

3.1. Towards a Lunar Governance Charter

"History is never repeated, but it borrows, steals, echoes and commandeers the past to create a hybrid, something unique out of the ingredients of past and present."
~ Simon Sebag Montefiore

Historic recurrence is the concept of similar events in history being repeated. This concept lends credence to the adage that history repeats itself. Even as humanity expands its reach, influence, and development on the lunar surface, there is a fear that history will be cyclical. Regarding lunar governance, while the possibility of repeating the same political mistakes such as war, imperialism and predation is a possibility, it is not inevitable. With respect to international space diplomacy, we are fortunate enough to see its history from a rather short-distance observation. This is the benefit of hindsight: it allows the space community to follow the development and patterns set up by legal mechanisms. Once we began to track international space diplomacy, one thing became evident: there is a pattern. The regulatory tools devised in UNCOPUOS seemingly follow a life span of roughly 20 years. Starting with the Outer Space Treaty of 1967 ("OST"), the development of the five main binding space treaties, the *Corpus Juris Spatialis,* spans to 1984, ending with the Moon Agreement. For the subsequent 20 years, the space treaties were succeeded by a series of non-binding space principles centred around specific technology and benefit-sharing. At the turn of the century, the following two decades have been characterised by the development of non-binding guidelines helping shape certain space industry practices. Treaties, principles, and guidelines characterised the past 60 years of international space diplomacy. With lunar development being one of the more pervasive themes of today's "Golden Age of Space", the question becomes: what next?

In the ever-changing landscape of space policy, we argue that this is the time for charters. With this term we refer to a legal document enacted to define the essential features and boundaries of a legal framework through the solemn commitment of its signatories. Examples of famous charters used in this sense include the *Magna Carta Libertatum*, the Charter of the United Nations and the Charter of Fundamental Rights of the European Union. All these documents implement the general properties of charters in different ways, depending on their context and purposes. Based on the analysis conducted in our Report, we found that charters can support the further development of international space law in many

ways. Structurally, charters fit in a time where technology and economic development constantly progresses at a rapid rate, like ours. Conceptually, charters encapsulate a general but coherent approach to the regulation of a given topic, like the one we need now. Charters can help consolidate general consensus on fundamental principles of space law, enabling the development of that middle level framework which is needed to operationalise the Outer Space Treaty. Building upon that shared ground, charters can be used to clarify common understandings of new concepts at a principle level, allowing for the harmonious development of future, more specific regulation. Finally, as shown by the previous examples, charters have a flexible legal nature: they can either be binding or non-binding, depending on the intent driving their processes. As we have seen before, the need for lunar governance will inevitably strengthen with time. Therefore, we need a lunar legal ecosystem that can evolve at a similar pace of technological and economic realities. This is why we propose a Lunar Governance Charter ('Charter'). We believe that a Charter could help us achieve the peaceful development of the Moon as well as the sustainable use of its resources. Broadening the discourse initiated already in various policy documents, a Lunar Governance Charter can clarify issues or misunderstandings on concepts such as safety zones, priority rights, heritage protection, interoperability, and commercial space. A Lunar Governance Charter can also consolidate existing consensus on the operationalisation of fundamental principles of space law within the context of lunar activities. Framed in these terms, a Lunar Governance Charter can constitute a shared reference framework for adaptive governance that its *Signatories* can build upon. As a result, a Lunar Governance Charter will help us move forward from solid foundations while also providing guidance for building new ones.

Consistently with the analysis conducted throughout this Report, our proposal for a Lunar Governance Charter is not conceived as a finished product, but rather as the beginning of it. At the same time, we felt the responsibility of accompanying it with some substantive and procedural suggestions to help framing the development of multi-stakeholder dialogue. These recommendations are laid down in the next parts of this section. To begin with, Section 3.2 addresses the fundamental topics that we believe should be included in the Charter. These could be divided into two groups: the foundations of the Charter and its potential provisions. Within the first group, we believe that a Lunar Governance Charter should begin by restating the fundamental rules of international space law that we all share, as well as the guiding principles animating the development of the way forward. Within the second group, we believe that a Lunar Governance Charter should address inclusiveness, interoperability, human life protection, heritage preservation, science/business balance, use of lunar resources, safety zones, registration and liability, minimum coordination and conflict resolution. Finally, while we naturally recognise UNCOPUOS as the primary forum for the negotiations of a Lunar Governance Charter, we also believe the global significance of the Moon requires a multi-stakeholder process drawing from the various perspectives of all humanity. Therefore, Section 3.3 provides two fundamental procedural considerations for the development of the Charter.

For one year, we listened to the voices of the space community. Ultimately, the time has come to express our own. Mindful of plurality benefits, we would like for our voice to help synchronise all the others, turning the current cacophony into a harmonious choir. Above all,

we hope to spark the bright flame that has lighted the best years of international space law, catalysing the existing potential for developing a lunar legal ecosystem that can honour the exploration and use of the Moon as the province of all humankind.

3.2. Suggested Topics for a Lunar Governance Charter

This subsection presents the fundamental topics that we believe should be covered in a Lunar Governance Charter. As mentioned, the goal is to provide a useful starting point for the beginning of an open multi-stakeholder dialogue in this respect. As such, the following list is inherently non-exhaustive to avoid any constraints for the future development of the Charter.

Structurally speaking, this subsection discusses 12 fundamental items for the substantive development of a Lunar Governance Charter. For the benefit of the reader, each item includes a synthetic recommendation and then an elaboration on its reasons and goals.

3.2.1. Fundamental Principles of Space Law

Recommendation

A Lunar Governance Charter should naturally build upon the Outer Space Treaty and invite all States planning to engage in lunar activities to ratify it. To this end, the Charter should underline the critical importance of the fundamental principles of international space law as laid down in the OST for the peaceful and sustainable development of the Moon. As a complement to these principles, the Charter should recognise the usefulness of developing rules of responsible behaviour for sustainable activities within the lunar environment, similar to those provided for terrestrial ones by the 2007 UN Debris Mitigation Guidelines (UNDMG) and the 2019 Long-Term Sustainability Guidelines for Outer Space Activities (LTS).

Elaboration

In our views, any proposal for a lunar governance system should be firmly rooted in the fundamental principles of international space law as laid down in the OST. Accordingly, we suggest that the proposed Lunar Governance Charter should emphasise the importance of the OST as a critical starting point for the peaceful and prosperous exploration and use of the Moon. To this end, we suggest that the Charter directly recalls the following principles:

- Freedom of exploration and use of outer space and celestial bodies, which shall be conducted for the benefit and the interests of all countries and shall be the province of all humankind; international cooperation in scientific investigation (Article I OST);
- Prohibition of national appropriation of outer space and celestial bodies (Article II OST)
- Applicability and respect of international law in the exploration and use of outer space and celestial bodies, in the interest of maintaining international peace and security (Article III OST);
- Use of celestial bodies for exclusively peaceful purposes (Art IV OST);

- Consideration of astronauts as envoys of humankind and rendering of all possible assistance to them (Art. V OST);
- International responsibility of States for national activities in outer space and celestial bodies; exploration and use of outer space and celestial bodies by private entities under authorisation and continuing supervision of the appropriate State (Art. VI OST);
- International liability of States for damages caused by space objects (Art. VII OST);
- State's jurisdiction and control over registered space objects and personnel thereof (Art. VIII OST);
- Due regard to the corresponding interests of other States in conducting all space activities (Art. IX OST);
- Voluntary sharing of information concerning the nature, conduct, locations and results of space activities (Art. XI OST)

To complement the above mentioned OST principles, we suggest that the Charter should also recognise the usefulness of developing rules of responsible behaviours for sustainable activities similar to those provided for terrestrial ones by the UNDMG and the LTS. We believe it would be helpful to invite all States to develop similarly driven practices as adjusted and tailored based upon the features of the lunar environment.

3.2.2. Guiding Principles for a Lunar Governance Charter

Recommendation

The development of a Lunar Governance Charter should be guided by the principles of adaptive governance and inclusiveness. The purpose of this Charter should be to enhance the peaceful development of the Moon as well as the sustainable use of its resources. To achieve these goals, the Charter should act as a minimum but comprehensive starting point providing the basis for further international and national regulation of lunar activities.

Elaboration

Based on the fundamental rules presented in the previous section, we believe that the Charter should be guided by new principles recognizing the necessities of the upcoming landscape surrounding future lunar activities.

First is the principle of adaptive governance. The responsiveness of regulatory systems to technology is indeed pivotal today. The regulatory frameworks must be flexible enough to allow the adoption of different business models for the healthy and sustainable development of commercial and non-commercial activities. Second, the principle of inclusiveness. The lack of participation in international discussion forums by private actors has created legal uncertainty in the past. Today, the lunar governance system should be inclusive towards non-governmental and commercial entities, incorporating different voices and recognising the plurality of actors. To us, inclusiveness means making choices based not only on

technology, scientific and commercial developments but also on history and cultural considerations.

Framed in these terms, the Charter should aim to achieve the peaceful development of the Moon and the sustainable use of its resources. As it will be seen in the next items, this can only come with oversight and accountability, coordination and cooperation between actors, and interoperability between systems. The implementation of these guiding principles will be further expanded in the following items.

3.2.3. Inclusiveness

Recommendation

A Lunar Governance Charter should stress the importance of the province principle laid down in Article I OST and invite all States to cooperate and be inclusive in their exploration and use of the Moon. Accordingly, the Charter should invite all States involved in Lunar operations to engage in capacity building and benefit sharing activities to the greatest extent practical, taking into particular account the needs of developing countries. To this end, the Charter should include an Annex laying down a protocol for internationally agreed benefit sharing and capacity building mechanisms for lunar activities. Following the principle of adaptive governance, this Annex should be updated by means of dedicated UNGA resolutions as developed in UNCOPUOS.

Elaboration

Inclusiveness and benefit sharing are usually controversial topics given the complexity of many related terms and their geopolitical implications, such as sharing resources or intellectual property. It is also challenging to reach a consensus of what a "developing country" is and whether its definition and the one related to "space-faring countries" are mutually exclusive. Being "developing countries" the term most used in international documents and thus most understood and accepted, we decided to use it in this document.

We firmly believe that benefit-sharing and inclusiveness should be kept front of mind in the development of a Lunar Governance Charter. Regulations should proceed with the aim of creating a level playing field in terms of research capabilities amongst all space-faring and space-aspirational States. We also think that engaging as many actors as possible, whether States or private entities, is key to achieving the sustainability of lunar activities. This will enable a broad range of actors to participate in outer space activities, thereby facilitating and advancing global innovation on the basis of effective knowledge generation and creating a 'common pool' of knowledge. Furthermore, inclusivity and benefit-sharing activities are necessary to foster and incentivise actors from developing nations to meaningfully contribute to lunar developments, which gives them an active voice in the evolution of regulations and ensures a more sustainable development path. As such, we recommend that the Charter be drafted such that it pays particular attention to the unique perspective of developing nations and the diverse voices of their constituents. We believe that if knowledge

of discoveries were shared freely and globally, opportunities for advancement could be identified earlier, and financing could be marshalled more rapidly to expedite progress for all.

In this regard, we recommend, along with the Charter, to draft a Protocol that defines the mechanisms, terms, and commitments under which such benefit-sharing will be conducted, measured, and followed. While we acknowledge that these mechanisms, terms, and commitments will need to be defined and agreed upon during international discussions, we recommend here a brief framework of inclusive development based on (1) multi-stakeholder dialogue, (2) open-access and open opportunities, and (3) capacity building, to be incorporated in future regulatory considerations.

1) Multi-stakeholder Dialogue

During our interviews, we witnessed how non-State actors (i.e. private entities, non-profits) are taking more relevance in space exploration activities. We believe that such entities can play a crucial role in further developing countries' lunar capacities by accelerating technology transfer and commercialisation of space applications to create an appropriate environment that benefits their home countries. We recommend that these entities are considered by States in the Charter and Protocol and included in the global dialogue.

2) Open Access and Open Opportunities

We believe that open access to scientific research data enabling lunar exploration will yield a positive and effective approach to sharing benefits amongst all space-faring and space-aspirational nations. In the scientific community, open access to data is essential in facilitating rigorous independent testing and replicating findings. Further, open access to data enables *ex-situ* access to knowledge for non-spacefaring or non-participatory actors, thus increasing the 'common pool' of expertise. As such, it allows for the full participation of developing nations in the global progress of scientific research. We believe this is an effective way of promoting the interests of developing or space-aspirational countries as they can choose how to utilise the data in a manner that best suits their needs, enhancing opportunities to develop their programmes and procedures. To safeguard the interests of scientists and commercial users, limitations to open access should be considered as appropriate for the specific situation. One way to do that is through “embargo” periods, which allow users to keep materials and data private for a certain period, e.g., to secure confidentiality while publishing the first results of research or while applying for a patent.

To complement open access to scientific information, we suggest the Charter and protocol should include a reasonable baseline to allow nationals from developing countries to access education, research, training and professional development opportunities. Today, these are targeted to individuals from the States owners of such programs. By broadening educational opportunities, we can reduce the current divide between countries by increasing the number of trained professionals in all nations.

3) Capacity-Building

Capacity-building is the process by which an entity (be it a State or an individual stakeholder) obtains and improves the skills, knowledge, tools, equipment, and resources required to advance competently. In the context of lunar development, States could engage in capacity-building by providing training courses, technical advisory services, or resources to other States. States could also foster foreign workforces' development by engaging in collaborative projects or administering fellowship programmes in space science and technology applications. The Emirates Mars Mission is an exemplary capacity-building model in which multifaceted international collaboration amongst the UAE, the USA, and Japan contributed to the Arab world's first interplanetary spacecraft, a tremendous technological leap forward. Consistently with this spirit, the Emirates Mars Mission will produce the Martian atmosphere's first global map and will release these data to the international scientific community without any embargo. Furthermore, the mission has evoked increased interest in STEM subjects: enrolment by UAE nationals in STEM university courses has risen by around 12% a year, six times faster than the overall trend in enrolment, with the highest increase in women. This example highlights that targeted capacity-building programs can rapidly develop a nation and create opportunities to advance our global sphere of knowledge.

3.2.4. Interoperability

Recommendation

A Lunar Governance Charter should recognise the fundamental importance of interoperability for the sustainable development of the Moon. Based on the principle of subsidiarity, the Charter should invite States to identify a global platform for the multi-stakeholder development (and subsequent regular updates) of multiple open international standards for lunar activities.

Elaboration

Interoperability is a critical element of sustainability. Therefore, we suggest that the Charter should encourage the development and use of interoperable space systems and equipment. In compliance with the LTS Guidelines, the Charter could begin a global dialogue for the development and use of shared infrastructures, avoiding the duplication of infrastructure and enhancing the reusability and repurposing of lunar infrastructure.

At the same time, we believe that interoperability should not come at the cost of inertia. Therefore, we advocate for a flexible process of standards development that allows for rapid upgrades and consultations to continuously follow the evolution of space technologies. In this respect, we regard the IETF process for internet standards as a useful source of inspiration for organic ways of establishing standards focused on practical implementation.

With interoperability comes the composability of infrastructures and space assets that will be of paramount importance to ensure crew safety, reduce development costs, and foster commercial activities. Composability between resource-producing and resource-consuming

elements allows for synergies and competition on the production side and resilience on the consumer side. In particular, we believe that all aspects relating to life support systems and docking should be heavily standardised on an international level. As it will be further discussed in the next item, lunar life support systems, supplies, and docking mechanisms should be universally interoperable with each other, regardless of political considerations.

3.2.5. Human Life Protection

Recommendation

Building upon Art. V OST and the ARRA, a Lunar Governance Charter should declare the protection of human life as an absolute priority for every lunar operation. Accordingly, the Charter should invite all States to render all possible assistance to astronauts in distress no matter their nationalities. To this end, the Charter should underline the critical importance of developing interoperable human-life-support systems based on open international standards and invite States to prioritise them within the multi-stakeholder process suggested above.

Elaboration

Under existing international space law, States shall render all possible assistance to astronauts in distress no matter their nationalities or purpose in space. This is even more important on the Moon, where all actors shall adopt all practicable measures to safeguard the life and health of astronauts. In this sense, we propose that the term astronauts should be interpreted in an all-encompassing manner as to include any and all persons either (1) onboard a spacecraft or space facility, (2) on the Moon or other celestial body, or (3) transiting to one of the locations mentioned above. Prevention is the cornerstone of crew health maintenance and protection. Preventing medical incidents will become imperative in the context of the evolving and expanding human spaceflight industry. To reduce the risk of health-related risks occurring in space, we suggest developing a set of robust and internationally agreed-upon medical screening and medical risk assessment approaches that limit lunar spaceflight only to those in good health. To enable sustainable growth of governmental and commercial lunar spaceflight activities, the criteria should be less stringent than those currently in place for professional astronauts and crewmembers visiting the ISS. At the same time, criteria should be rigorous enough to select out any pre-existing medical conditions that might threaten the safety of the crew or the goals of the mission. In time, improvements in life support technology and human factors can help the future relaxation of astronauts' selection criteria for lunar missions.

In order for States to adopt all practicable measures to safeguard the life and health of astronauts, there is an immediate need to develop and widely integrate life-support systems that can be compatible with each other regardless of their developer. To this end, NASA, alongside the Canadian Space Agency (CSA), Roscosmos, the European Space Agency (ESA), and the Japanese Aerospace Exploration Agency (JAXA), have collaboratively prepared draft interoperability standards related to Environmental Control and Life Support System (ECLSS). The purpose of these standards is to "provide common basic performance parameters based on applicable, internationally recognised standards to allow developers to

independently develop ECLSS technology solutions which can be easily compared and seamlessly integrated". We strongly advocate for the adoption of these standards for lunar exploration and recommend that States coordinate efforts with private stakeholders to ensure their implementation. Furthermore, we recommend that a physician is included in any space-faring crew to ensure optimal operation and maintenance of medical systems.

3.2.6. Heritage Preservation

Recommendation

A Lunar Governance Charter should define a mechanism for identifying internationally recognised heritage sites on the Moon and invite all States to refrain from altering them to the greatest extent practical. To this end, the Charter could include an Annex providing a non-definitive list of internationally recognised heritage sites on the Moon. Following the principle of adaptive governance, this Annex should be updated by means of dedicated UNGA resolutions as developed in UNCOPUOS.

Elaboration:

We believe the preservation of heritage sites on the Moon is a critical component of any lunar governance system. Lunar Heritage sites hold an immeasurable value from different perspectives. Historically and culturally, they represent the first steps taken by humanity in becoming a space-faring civilisation, and as such, they must be preserved and reckoned. Scientifically, some space objects left on the lunar surface have an incomparable value due to their prolonged exposition to the lunar environment.

We are aware that not all materials on the Moon are worthy of preservation. Hence, it will be necessary to distinguish between the objects to be protected, those that could be reused to favour the development of a sustainability cycle and those that should be appropriately disposed of as debris. Thus, we believe the Charter should operate on two levels.

First, the Charter should identify a mechanism to select internationally recognised sites, which in our view should be only those enjoying a universal value. On Earth, this mechanism occurs through the selection at the national level of sites considered worthy of preservation. UNESCO then examines the lists created by States to finalise world heritage status attribution to the proposed sites. Since this mechanism is essentially based on States' sovereign control over the proposed sites, it cannot be applied to space heritage. To close this gap, the Charter could provide a starting point by developing an Annex providing a non-definitive list of internationally recognised heritage sites on the Moon. To update this list, the Charter could invite States in UNCOPUOS to develop a permanent working group responsible for selecting lunar sites worthy of preservation in cooperation with relevant multi-stakeholder actors. On a regular basis, the plenary committee could then continuously update the Annex based on the proposals agreed upon in the working group. Second, the Charter should lay down shared foundations for the development of appropriate measures capable of preserving lunar heritage sites in compliance with the principle of free access to all areas of celestial bodies under Article I OST.

3.2.7. Science / Business Balance

Recommendation

A Lunar Governance Charter should recognise that both scientific and commercial activities are equally important and that their interests should be adequately balanced on a case-by-case basis. To protect the fundamental freedom of scientific investigation on the Moon, the Charter should invite States to develop, in an Annex with a list of internationally recognised scientific sites on the Moon, including appropriate preservation measures, as soon as technological developments will allow for such assessments and in cooperation with relevant stakeholders. Following the principle of adaptive governance, this list should be updated through dedicated UNGA resolutions as developed in UNCOPUOS. To promote the development of a Lunar economy, the Charter should recognise the role of pioneering commercial operators and invite States to take appropriate measures to support their activities and protect their legitimate interests.

Elaboration

During our interviews, we realised that although scientific purposes have primarily driven space exploration, commercial activities will be critical to achieving its sustainability. Under the proper guidance, we believe that scientific and commercial activities can be naturally complementary to each other. On the Moon, we believe they should be conducted in a joint-manner to generate knowledge (for instance on geology, cosmology, and vacuum/ reduced-gravity sciences) while also producing economic benefits to contemporarily fund its exploration and sustain human activities thereby. In other words, the cooperation between scientific and commercial endeavours is a two-way street. For example, through technology transfer, scientific discoveries will provide new insights on how to conduct commercial activities. Complementarily, data sets generated by commercial activities can be transferred or released to the scientific community for studies. These benefits could be best achieved through partnerships between private companies and research institutions, for instance, to collect samples from various sites where commercial activities are to be conducted. To this end, the Charter should invite States to provide adequate incentives for commercial entities conducting and supporting scientific activities, for instance through the inclusion of a reasonable number of scientific purposes in their commercial missions.

To protect the fundamental freedom of scientific investigation on the Moon, we recommend that the Charter should invite States to develop an Annex with a list of internationally recognised lunar scientific sites. This list and the measures to adequately protect every site shall be internationally discussed, agreed and implemented by involved stakeholders as technology development permits. In case a specific site is of particular interest to both scientific and commercial actors, the Charter should include appropriate measures to ensure significant and sufficient activities are undertaken to gather data and samples for scientific purposes in a reasonable amount of time to allow for the subsequent development of commercial activities. Finally, the Charter should invite States to welcome and support all private activities beyond those animated by scientific or commercial purposes.

3.2.8. The Use of Lunar Resources

Recommendation

A Lunar Governance Charter should recall that while the Moon is free for exploration and use by all States, this freedom is subject to the applicable limits as defined by existing international space law. In accordance with the principle of adaptive governance, we believe these limits must evolve in time to reflect scientific, technological, and economic developments. At the very least, the Charter should require that the Moon's territorial-based uses must be limited in time and size to ensure compliance with Articles I and II OST. Further, we suggest that the Charter acknowledges that the definition of what constitutes a lunar resource will likely evolve in time due to scientific, technological, and economic advancements and that related laws and governance principles must adapt accordingly. To ensure the sustainable development of the Moon, the Charter should invite States to develop an Annex with a list of internationally recognised scarce resources and appropriate preservation measures as soon as scientific and technological occurrences will allow for such assessments. Following the principle of adaptive governance, this list should be updated through dedicated UNGA resolutions as developed in UNCOPUOS.

Elaboration

The use of lunar resources is a complex topic driven by both public and private interests. The scientific community widely recognises that the sustainable and large-scale exploration and development of space beyond Earth orbit will only be made possible by the use of local resources. At present, the extent to which off-Earth resources can contribute to public and private space activities cannot be exactly determined due to the lack of sufficient and reliable data on their availability and the economic viability of their extraction and use. Consequently, our determination of what constitutes a highly valuable or limited resource is likely to evolve as more data becomes available, and so will also the related need to regulate their access and use. Therefore, we find it essential that the concept of what constitutes a *lunar resource* and the legal conditions for their access and use should evolve side by side. We also believe that the unrestricted use of lunar resources by public and private actors alike is a fundamental prerequisite for the sustainable development of the Moon. Accordingly, any governance system for lunar activities should be mindful of the critical role that private industry can play and the securities required by commercial investments in lunar infrastructure. Therefore, and pursuant to the principle of adaptive governance, we believe that the implementation of the principles of international space law must evolve in accordance with technological and economic realities.

The freedom to explore and use outer space is one of the cornerstones of international space law. Pursuant to Article I OST, States are free to engage in space activities under the conditions established in its provisions. In particular, the use of (lunar) resources is allowed as part of the general freedom to use celestial bodies. Conversely, this freedom is also subject to the limits defined in other applicable OST provisions, including but not limited to Article I itself and Articles II, III, IV and IX OST. For the early stages of activities on the Moon, compliance with the existing rules will operate at two levels. First, under Articles I and II OST,

no State shall exercise permanent and exclusive control over the territories of the Moon. Therefore, the Charter should require that territorial-based use of the Moon be limited in time and size, depending on the nature of the activity and considering the commercial needs of private operators. Second, under Article IX OST, lunar resources shall be used with due regard to the corresponding interests of all other States Parties to the OST. This obligation is particularly significant for the preservation of scarce lunar resources insofar as it prevents early actors from using such resources at the expense of future parties. Due to the variety of resources available on the Moon and the limited information available today, we believe that the Charter should promote an open and flexible concept of *lunar resources* to be adjusted based on scientific, technological, and economic occurrences. Finally, to appropriately reflect the evolving nature of lunar resources and their economic potential, we recommend that the Charter invites States to develop an Annex providing a list of internationally recognised scarce lunar resources, including appropriate preservation measures, as soon as scientific and technological advances allow such assessments. Following the principle of adaptive governance, this list should be updated through dedicated UNGA resolutions as developed in UNCOPUOS to ensure its continuing relevance in light of the latest occurrences in lunar activities.

3.2.9. Safety Zones

Recommendation

A Lunar Governance Charter should define the fundamental purposes and features of safety zones. To this end, we suggest that the purpose of safety zones should be to avoid harmful interference among lunar operations. Further, we recommend that the size of safety zones should be limited to what is strictly necessary for avoiding harmful interference. Finally, we believe that the temporal extension and classification of safety zones should always be connected with ongoing operations in the concerned area. In compliance with Articles I, II, and IX OST, the Charter should clarify that safety zones cannot be keep-out zones and that actors entering a safety zone should previously consult with the State who declared it. To foster transparency and ensure coordination, the Charter should invite States to timely and publicly declare their safety zones to the UN under Art. XI OST.

Elaboration

As seen in Section 2, safety zones are perhaps the most contentious topic within the global debate on lunar governance. If defined and appropriately coordinated, safety zones can play an essential role in avoiding harmful interference between different lunar surface activities. Therefore, we believe the Charter should clarify their fundamental purposes and limits of applicability to enable their potential as a valuable tool of coordination among lunar activities. In this respect, and pursuant to Articles I, II, and IX OST, the Charter should clarify that safety zones cannot be used as keep-out zones excluding all actors other than the State declaring them. Based on the hearings and reviews we conducted, we concluded that there most likely is no single scope of a safety zone that adequately covers the diverse activities performed on the Moon. Therefore, we propose expanding the concept of safety zones and introducing several zones requiring different coordination levels between actors. For

example, a safety zone containing a crewed base or a nuclear power source must be approached or passed through with more care than a zone that includes a robotic lander. In this respect, we believe the Charter could provide the basic rules enabling *ad hoc* coordination between the actor wishing to enter the safety zone and the one who declared it.

To prevent abuses, the Charter should expressly state that the extension of a safety zone must be limited to the smallest area required to ensure the safety of operations conducted thereby. For similar reasons, safety zones must always be connected to ongoing operations. Once operations cease or their nature or scope changes, the extent and classification of the associated safety zone must be adapted accordingly, or its declaration must be revoked altogether. In this respect, we expect safety zones to differ vastly in size and duration, ranging from large long-term zones to protect crewed bases and their support equipment to short-term zones to ensure a safe lunar spacecraft landing.

Besides ensuring the safety of operations, we argue that safety zones could also help establish liability for operations on the lunar surface. Actors entering a safety zone must previously consult with the State who declared it. Unjustified failure to do so should be understood as gross negligence and entail a presumption of fault for any damage caused. Conversely, the State declaring a safety zone should be considered at fault for any damage caused within the zone to compliant actors following the received instructions.

We believe that the legitimate and effective deployment of safety zones depends on the establishment of a transparent international notification process. Therefore, we propose that the Charter invites States to timely and publicly declare their safety zones to the UN under Art. XI OST. Pursuant to this article, States can voluntarily share information on their space activities with the public and the international scientific community by disseminating them through the United Nations Secretary-General. The existing notification mechanism, which today counts roughly 30 submissions by States, could be further improved by UNOOSA to specifically facilitate sharing of and access to information on safety zones.

3.2.10. Liability & Registration

Recommendation

A Lunar Governance Charter should invite all States involved in Lunar activities to ratify both the Liability and Registration Conventions. To enhance the applicability of liability rules, the Charter should clarify that States deviating from the standards developed pursuant to the Charter should be considered at fault in case of damages caused to compliant States. To promote transparency and foster coordination in the exploration and use of the Moon, the Charter should invite all States to promptly register their lunar objects and provide fundamental information on their nature, location and purposes.

Elaboration

Both the Liability and Registration Conventions are widely recognised as essential complements of the rules laid down in the OST. Accordingly, we suggest that the Charter should invite all States involved in Lunar activities to ratify both Conventions to ensure the

uniform application of their rules to the exploration and use of the Moon. At the same time, our analysis indicates that both Conventions could benefit from further clarifications, especially within the context of lunar governance. To this end, we developed one suggestion for each of the Conventions. Regarding the Liability Convention, we believe that the Charter's principles could be instrumental in providing a shared standard of "fault" under Article III LIAB. Therefore, we suggest that States deviating from the Charter's provisions should be presumed to be at fault for any damage caused to compliant States. We further believe that the application of the Registration Convention will play a crucial role in the peaceful and orderly development of the Moon. Accordingly, we suggest that the Charter invites all States to promptly register their lunar objects and provide essential information on their nature, location and purposes.

3.2.11. Minimum Coordination

Recommendation

In accordance with the principle of adaptive governance, and building upon existing norms of international space law, a Lunar Governance Charter should identify minimum mechanisms for international coordination among both planned and ongoing lunar activities. To this end, the Charter should invite all States to proactively share essential information on their lunar activities under Article XI OST. Conversely, the Charter should remind all States of their obligation to pay due regard and consult in case of potentially harmful interference with said activities under Article IX OST. To ensure uniformity in the national regulation of lunar activities, the Charter should invite all States to develop dedicated licensing systems for private lunar missions based on the principles of this Charter. To prevent contrasts among these missions, the Charter should invite all States to mutually recognise foreign licenses on a basis of reciprocity.

Elaboration

We believe that the current lack of appropriate international coordination mechanisms among planned and ongoing lunar activities is a serious threat to the peaceful and sustainable development of the Moon. Recognising that coordination mechanisms should evolve based on the principle of adaptive governance, we suggest that the Charter could build upon existing international space law norms to provide the minimum level which is needed at present. In the early stages of lunar activities, we believe that the enhanced, combined application of Article IX and XI OST could prevent potentially harmful interferences through general transparency and *ad hoc* coordination. Proactively sharing essential information on the nature, location, purposes and results of lunar activities under Article XI OST would enable and enhance the application of the coordination mechanisms provided by Article IX OST. Consequently, being informed about planned and ongoing activities on the Moon will provide a valuable parameter for exercising due regard and assess the need for consultations under the same article Accordingly, the Charter should invite all States involved in lunar activities to share information on their lunar activities under

Article XI OST and stress their usefulness in implementing the obligations laid down in Article IX OST.

In light of the increasing relevance of private lunar activities, any lunar governance system needs to be complemented at the national level. Accordingly, we propose that the Charter invites all States to develop dedicated licensing systems for private lunar missions based on the Charter's principles. In this respect, we believe it is critical to create dedicated licensing systems for lunar activities to address all the involved aspects holistically. To ensure uniformity in the national regulation of lunar activities, we recommend that all States develop their licensing systems based on the Charter's principles. Finally, leveraging on the Charter as shared regulatory ground, we further suggest States agree on the mutual recognition of foreign licenses to prevent contrasts in their implementation.

3.2.12. Conflict Resolution

Recommendation

In order to preserve the peaceful exploration and use of the Moon, a Lunar Governance Charter should stress the importance of internationally recognised mechanisms for the amicable resolution of disputes, in case bilateral negotiations would prove unsuccessful. As a starting point, the Charter should invite all States involved in lunar activities to include references to arbitration before international institutions like the Permanent Court of Arbitration (PCA) or the Dubai Space Court (DSC) within their agreements and contracts.

Elaboration

While recognising the importance of bilateral negotiations, we believe that the peaceful and sustainable development of the Moon will also depend on the availability of internationally recognised mechanisms for the amicable resolution of space disputes. Without effective tools to handle disagreements, the balance among lunar activities risks to rely on the rule of the strongest rather than on the rule of law. As a starting point, we recommend the inclusion of arbitration clauses before international institutions like the PCA or the DSC as a subsidiary mechanism for the resolution of lunar disputes within relevant agreements and contracts.

Over the last 20 years, arbitration has emerged as a successful tool to settle disputes also in various areas of international law. Arbitration is also enforceable under the 1958 New York Convention. The PCA is widely recognised as a prestigious international arbitrator since two centuries. Within the space community, the PCA was the first organisation to purposely devise a set of dedicated rules for the effective resolution of space disputes in 2011. For the application of these rules, the PCA relies on two specialised panels of worldwide arbitrators and experts. Further, international arbitration for outer space disputes before the PCA offers an autonomous legal standing to private parties, in line with the increasingly relevant role of commercial actors. Similar benefits are offered by the DSC, which has been established within the Dubai International Financial Center in 2021 and may emerge as a suitable forum for space arbitration. Finally, our proposal is without prejudice to the relevance of other international arbitrators as well as of traditional fora like the International Court of Justice.

3.3 Procedural Avenues for developing a Lunar Governance Charter

This subsection presents two complementary procedural avenues for the development of the proposed Lunar Governance Charter. Structurally speaking, for each avenue the subsection presents a synthetic recommendation and then elaborates on its rationale and potential implementation.

3.3.1. Multilateral Development

Recommendation

We recommend that UNCOPUOS should be the primary forum for the development of the proposed Lunar Governance Charter. To begin this process, we suggest the establishment of a new agenda item on "Adaptive Governance for Peaceful and Sustainable Lunar Activities" within the appropriate UNCOPUOS subcommittee(s). Consequently, we recommend entrusting the development of the Lunar Governance Charter to a dedicated working group established under the proposed agenda item.

Elaboration

As the competent UN body in charge of enacting international space law, UNCOPUOS should play a central role in the development of a Lunar Governance Charter. After careful consideration of the different options available, we recommend that this process should begin with the establishment of a new agenda item on "Adaptive Governance for Peaceful and Sustainable Lunar Activities" within the appropriate UNCOPUOS subcommittee(s). While leaving the decision to the discretion of the Committee, we believe that the development of the Charter should result from multidisciplinary efforts drawing from the expertise of both its sub-committees. Following, we recommend entrusting the Charter's development to a dedicated working group established within the relevant subcommittee under the proposed agenda item on lunar governance. We believe that this solution would allow to efficiently negotiate the Charter while still preserving the opportunity for general discussions. To promote multi-stakeholder contributions, we suggest that the working group should be open to UNCOPUOS' observers and allow for their active participation in its activities.

In parallel to the adoption of a new agenda item, we recommend that the scope of the recently proposed Working Group on Space Resources should be adjusted in two complementary directions. First and foremost, we suggest that the proposed working group should not exclusively focus on space resources, as their governance cannot be considered in isolation. On the contrary, space resources need to be discussed together with the other crucial topics addressed in the previous subsections (to name a few: safety zones, registration and heritage protection). Accordingly, we recommend expanding the group' scope to include fundamental topics related to the peaceful and sustainable conduct of lunar activities. Second, we suggest that the proposed working group should not discuss space resources in general, as the solutions to their issues are inextricably related to the environment in which they are performed. Lunar resource activities' regulation should differ from the one developed for asteroid mining or Martian resource activities. The issues at stake, the configuration of these environments, and the different timelines associated with

their exploration are too different for being addressed altogether in a meaningful way. In our view, a working group entrusted to exchange views and develop regulation for all kinds of space resource activities would reach consensus only on extremely general solutions, if any. Therefore, to enhance the proposed working group's practical impact, we recommend framing its mandate around space resource activities conducted on the Moon (and associated issues). In our view, this would enable the working group to develop tailored solutions for the specific problems posed by extracting and utilising space resources within the Lunar environment, without prejudice to the enactment of future regulations concerning their use on asteroids or Mars.

To implement the suggested actions, we recommend that States begin appropriate discussions on the regulatory priorities and needs for peaceful and sustainable lunar activities under the following agenda items: within the Plenary Committee, agenda item 14 on "Space Exploration and Innovation"; within the Legal Subcommittee, agenda item 5 on "Status and Application of the Five United Nations treaties on outer space"; within the Technical Subcommittee, agenda item 12 on the "Long term sustainability of outer space activities".

3.3.2. Multi-stakeholder Dialogue

Recommendation

We believe UNCOPUOS should not be the only body involved in the development of a Lunar Governance Charter. To ensure multi-stakeholder discussions, we recommend that the dedicated working group proposed in 3.3.1 admits UNCOPUOS observers, relies on the support of internal expert groups and dialogues with external multi-stakeholder platforms discussing similar topics. In case the Charter would not be entrusted to a dedicated working group, we recommend that States actively engage with non-governmental and private entities to leverage their perspective and contributions.

Elaboration

While recognising that UNCOPUOS will play a primary role in developing a Lunar Governance Charter, we also believe that the related process should include contributions from the global society at large. Accordingly, we suggest that UNCOPUOS becomes the focal point of a broader multi-stakeholder dialogue welcoming contributions from all international actors interested in lunar governance.

In the case the development of the Charter would be entrusted to a dedicated working group, we recommend that this platform should also include UNCOPUOS permanent observers. Complementarily, we suggest that the working group establishes procedures to solicit and include contributions from scientific and commercial actors not represented in COPUOS through the establishment of internal expert groups, similar to the process followed for the development of the LTS. Finally, we recommend that the working group develops appropriate institutional arrangements to engage in meaningful dialogues with globally recognised multi-stakeholder platforms discussing similar topics, like the International Space

Exploration Coordination Group, the E.A.G.L.E. Team, the Global Expert Group on Sustainable Lunar Activities and the Moon Dialogs Initiative.

In case the development of the Charter would not be entrusted to a dedicated working group, we recommend that States find ways for non-governmental and private entities to bring their perspective and contributions to the discussions conducted in UNCOPUOS. In our view, this integration could be promoted before, during and after the regular UNCOPUOS sessions. Before those, individual delegations should reach out to their respective constituents to solicit contributions on the fundamental regulatory issues involved in the exploration and use of the Moon. In parallel, UNOOSA should develop procedures to collect inputs from permanent observers as well as globally recognised multi-stakeholder platforms like those mentioned above. During the sessions, Members' delegations and UNOOSA should leverage the inputs received for the benefit of the diplomatic discussions. Permanent observers should be invited to give technical presentations and organise side events to substantiate their proposals and support the member States' work in plenary sessions. Finally, after the regular meetings, permanent observers should report their proposals and contributions to UNOOSA, distributing this information to the individual delegations and promoting follow-up actions as may be necessary.

4. CONCLUSION

This Report condenses the results of almost one year of intense work specifically focused on lunar governance development. Over this period, we met with 21 stakeholders worldwide to discuss the fundamental regulatory issues raised by the exploration and use of the Moon. One meeting after the other, we realised that all these actors had outstanding contributions that could enrich and enhance the global debate on lunar governance. In parallel, the very same feeling emerged from our assessment of recent developments in lunar policy. Ultimately, the lack of a shared narrative holding together these contributions emerged as the main problem currently undermining our lunar policy efforts. This became crystal clear when we looked at the history of lunar exploration to understand its implications on space law and policy development. Unsurprisingly, we found the most inspiring and productive years of both lunar exploration and space law have been those framed within the Apollo and Luna narratives. These two programs did much more than launching two groups of countries in the competition for landing humans on the lunar surface. They provided the push for the development of visionary rules and technologies that we still apply 60 years later. They unified the world in the pursuit of a better future in space.

At the E.A.G.L.E. Team, we value the ability to unite and converge above everything else. When we set foot to initiate the development of this document, our main goal was to provide a contribution that could simultaneously increase the value of all others by providing them with meaningful opportunities to be expressed. We wanted to inspire global actors and catalyse international discussions on the exploration and use of the Moon. With this purpose in mind, we birthed the idea of a Lunar Governance Charter as a shared narrative that could frame the global debate on lunar governance within pragmatic but also idealistic terms. Structured in the way presented in Section 3, we believe that a Lunar Governance Charter could constitute a useful reference framework for the evolution of adaptive governance. We trust a Charter can be critical for achieving the peaceful development of the Moon as well as the sustainable use of its resources, hopefully resulting in a thriving lunar ecosystem: a circular environment where all humanity can prosper and work together in true harmony. As mentioned, the Moon is just the beginning, a springboard for our future interplanetary society. Similarly, we truly hope that our Report could be just the beginning of a new process resulting in a global, intergenerational, and multistakeholder pact for the exploration and use of the Moon under a shared narrative of peace, inclusiveness, prosperity and sustainability. Sixty-two years ago, on July 20 1969, an eagle carrying two men had landed on the Moon. Today, as humanity prepares for the historical landing of the first woman, a new eagle with fourteen young space enthusiasts is taking off. And we cannot wait to see where it will land.

The SGAC Eagles

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