

Ethical and Cultural Considerations for Space Resource Utilization. Bailey C. Hopkins¹ and Frances Zhu¹,
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Introduction: As technologies advance and space travel becomes more feasible, the extraction and utilization of space resources are becoming a reality. However, these discussions often prioritize economic and scientific interests while neglecting cultural, ethical, and legal considerations. Throughout history, celestial bodies have played an integral role in shaping human civilization, serving as religious symbols, guiding navigation, and structuring calendars. The Moon, in particular, holds deep cultural and spiritual significance across various societies, from indigenous traditions to modern religious observances.

Yet, the potential commercialization of celestial resources raises pressing questions: Should certain celestial bodies be protected from exploitation? How can space law balance scientific progress with cultural preservation? What lessons can be drawn from historical precedents, such as conflicts over terrestrial resource extraction? And who should make these decisions?

To address these questions, the authors explore the intersection of space resource utilization and cultural heritage by first examining the Moon's historical significance across cultures. A review of a case study on Maunakea illustrates the potential conflicts that arise when development encroaches on culturally significant sites. The authors then analyze foundational treaties, draw parallels between seabed mining and space resource extraction, and conclude with policy recommendations to address gaps in the current legal framework.

The Moon in Human Civilization: The Moon is a universal constant in human history, serving as a fundamental tool for social, agricultural, and religious organization across nearly every civilization. For many cultures, the Moon is intimately linked to survival through agriculture and navigation. The concept of "planting by the moon" remains a global tradition, with various societies timing the sowing and harvesting of crops based on lunar phases to optimize yields. In North America, the naming of full moons, such as the Harvest Moon or Hunter's Moon, reflects this practical integration of lunar cycles into the seasonal labor of both colonial and Indigenous communities.

The Moon continues to dictate the rhythm of modern global life through major cultural festivals and religious observances. The Islamic Hijri calendar, for example, is purely lunar, determining the timing of Ramadan and Eid al-Fitr. Similarly, the Lunar New Year is a cornerstone of East Asian culture, while the Hindu calendar utilizes lunar positions to set the dates for festivals like Karva Chauth and Diwali. These practices illustrate how the Moon functions as a catalyst for social cohesion, synchronizing the activities of billions of people simultaneously.

In the 20th century, the Moon's cultural significance underwent a paradigm shift with the advent of the Apollo program. No longer just a distant deity or a timekeeping tool, the Moon became a symbol of human ingenuity and a physical destination. For the United States and the world, the Apollo 11 landing represented a watershed moment in the human narrative, transitioning the Moon from a subject of celestial wonder to a frontier for scientific discovery and international cooperation.

Case Study: Maunakea. Maunakea (4,207 m) is central to Native Hawaiian creation stories yet serves as a premier site for astronomical observation. While currently hosting 13 telescopes, the summit has faced decades of documented mismanagement, including chemical pollution and a historical failure to recognize sacred burial and religious sites. As synthesized by Rosenberg [1], Indigenous practitioners must navigate restrictive bureaucratic permitting to access the summit for religious use, a condition the Hawai'i State Supreme Court upheld in its 2018 approval of the Thirty Meter Telescope (TMT). This case illustrates a broader legal trend of prioritizing development and private interests over Indigenous Free Exercise claims. As lunar resource extraction transitions from theory to practice, consulting religious and Indigenous leaders is essential to avoid replicating these terrestrial legal and ethical conflicts.

Ethical Considerations for Space Resource Utilization. Deep-rooted spiritual significance raises ethical concerns about commercial exploration. Specific questions to consider are: Would the excavation of the Moon's surface be seen as a violation of its sacred role in global traditions? How should space agencies engage with Indigenous groups before undertaking resource extraction? Could the protection of certain lunar regions, such as the Apollo landing sites or naturally significant craters, be similar to cultural heritage preservation on Earth?

Review of Foundational Legislation: Foundational documents establish principles for international cooperation, define the legal status of outer space, and outline humanity's collective responsibilities.

The Antarctic Treaty and Outer Space Treaty. The first major treaty to outline the use of an area for international cooperation was the Antarctic Treaty [2]. The first article states that Antarctica will be used for peaceful purposes only. The third article promotes international cooperation by requiring information regarding scientific programs to be freely available, and the eleventh article outlines dispute resolution through the International Court of Justice. This treaty helped frame the Outer Space Treaty less than

a decade later [3]. The Outer Space Treaty's first article states that the exploration and use of outer space is for the benefit of all mankind. The second article prohibits national appropriation, meaning no nation can claim territory in space. Both treaties clearly define that areas of exploration are for the cooperative use of all mankind for peaceful purposes.

The Artemis Accords and Systemic Inequities. In 2020, NASA established the Artemis Accords to modernize the governance of civil space exploration [4]. While the Accords promote cooperation and outline the preservation of space heritage, Section 10 specifically permits resource extraction by arguing it does not constitute national appropriation under the Outer Space Treaty. This stance highlights a growing tension: while new legislation is being drawn up to manage space utilization, it continues to leave marginalized groups behind.

Recent legal scholarship by Posey [5] argues that this privatized, "first-come-first-served" model systematically marginalizes developing nations and the Global South. This extraction-focused trajectory directly conflicts with decades of advocacy, such as the Bogotá Declaration and the Moon Treaty, which sought to classify outer space as an equitably shared global commons. As geopolitical divides widen, evidenced by China and Russia abstaining from the Accords, the current legal pathway risks replicating terrestrial colonial and capitalist structures in the final frontier. To fulfill the foundational spirit that outer space is for everyone, future legislation must actively integrate these historically marginalized voices to prevent the monopolization of celestial bodies.

Parallels from Sea Mining to Space Resources:

Legal Lessons Learned from Deep Sea Mining. Deep-sea mining has been a point of debate in recent years. The United Nations Convention on the Law of the Sea recognizes the deep seabed as a common heritage of humankind [6]. The International Seabed Authority (ISA) organizes mineral-related activities, but currently, there is no formal role for Indigenous communities, and common heritage is interpreted mainly in economic terms [7].

This presents two legal pathways for Indigenous people to protect their rights. First, they can challenge the ISA's exclusion using the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) [8], which recognizes rights to free, prior, and informed consent. Additionally, the International Covenant on Civil and Political Rights (ICCPR) Article 27 states that minorities shall not be denied the right to enjoy their own culture or practice their religion [9].

The second legal pathway is to develop protected environments. In 2024, the United States designated the Chumash Heritage National Marine Sanctuary, spanning 116 miles of coastline [10]. Proposed by an Indigenous

group, it is co-managed by the Chumash people and federal agents and prohibits mining. Developing similar cultural heritage sites in space, protecting both man-made sites like Tranquility Base and natural phenomena like Olympus Mons, would protect cultural rights and align with Section Nine of the Artemis Accords.

Policy Recommendations: The current legal framework has notable gaps requiring immediate attention, with three key policy recommendations outlined below:

1) **Two-Tiered Penalty System:** Establish effective enforcement mechanisms by allowing governments to impose monetary fines on companies failing to comply with international regulations, proportional to the cost of the mission. The UN should also levy fines against non-compliant countries based on the scale and impact of the violation.

2) **Protected Cultural Sites:** Formally designate cultural heritage sites on the Moon, Mars, and other celestial bodies. These areas would be free from resource extraction, ensuring that certain regions remain intact. Additionally, resource collection should be restricted from areas that would have visible impacts on the lunar surface visible from Earth.

3) **Community Involvement:** Actively involve affected Indigenous and cultural groups in the decision-making process. Transparent communication, regular consultations, and respect for cultural beliefs will mitigate conflicts and foster inclusive policies.

Conclusion: Celestial bodies hold more than scientific and economic value; they are deeply embedded in human tradition. Existing legal frameworks establish broad governance principles but lack clear protections for cultural considerations. Without proactive safeguards in place, space exploitation may repeat historical mistakes of disregarding Indigenous and cultural voices in favor of economic gain. By integrating cultural impact assessments, establishing protected celestial sites, and respecting the historical importance of the stars, humanity can define ethical foundations for space exploration for generations to come.

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