

Simulated Astronaut, Real Dilemmas: The Uncanny Ethics of Space Analogue Tourism

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Abstract: The burgeoning industry of space analogue tourism, which simulates aspects of space travel on Earth, presents a new set of ethical considerations. While this sector holds the promise of democratizing access to astronaut-like experiences and inspiring a new generation of explorers, its expansion, like other forms of extreme tourism, introduces questions concerning environmental impact, social equity, and psychological and potentially medical welfare. This paper analyzes these dimensions, arguing that the industry's development must be guided by a robust and comprehensive ethical framework to ensure responsible growth which includes the potential for environmental degradation. Analogue sites are often located in fragile ecosystems, such as deserts or Arctic tundra, that mimic off-world environments. Without stringent regulations and a commitment to sustainability, this sector could inadvertently harm the very natural wonders it seeks to emulate. Furthermore, the issue of social equity is paramount. The high cost of space analogue tourism may start to create a "pay-to-play" model that excludes all but the most affluent. This exacerbates existing inequalities, commodifying an experience that, in its original context, is a collaborative effort for the benefit of all humanity. The ethical framework must address this by exploring accessible pathways for a more diverse range of participants, such as through subsidized programs. Finally, there is a critical ethical obligation to participant welfare. Simulating isolation, confinement, and high-stress scenarios without proper oversight can pose serious psychological risks. Operators must implement rigorous psychological screening and provide continuous, accessible mental health support throughout the mission. A failure to provide a comprehensive duty of care would be an ethical dereliction, placing participants at unnecessary risk for the sake of a commercial venture. By proactively addressing these challenges, the space analogue tourism industry can evolve responsibly, aligning its commercial goals with ethical conduct and the long-term well-being of both humanity and the planet.

Keywords: Space Analogue Tourism, Ethical Considerations, Environmental Impact, Social Equity, Psychological Welfare

1. Introduction

Extreme tourism, including space analogue tourism, is part of the broader category of adventure tourism which represents one of the fastest-growing niche sectors in global travel. This market encompasses commercial activities undertaken in unfamiliar, remote, or hostile environments, characterized by perceived or actual risk (Janowski et al., 2021, Zaid et al., 2023). The adventure tourism industry is widely delineated into two primary risk typologies based on the required skill level and the degree of risk exposure to the participant. Soft adventure tourism involves activities with relatively low risk and minimal requisite skill, such as guided hiking, organized camping, or snorkeling. Meanwhile, hard adventure tourism demands a higher level of specialized training, physical fitness, and proficiency, involving more dangerous activities such as advanced rock climbing, mountaineering, or specialized polar expeditions.

Extreme tourism is defined as the highest-risk subset of the "hard adventure" category. Extreme tourism focuses on activities that involve travel to inherently unsafe areas, often characterized by severe environmental conditions, high operational liability, or the deliberate pursuit of danger. This category stands alongside other specialized niches tourism such as disaster tourism, ghetto tourism, or the high-risk activities involved in urban exploration.

The recent increase of adventure and extreme tourism, including high-risk activities such as mountaineering, deep-sea exploration, and space tourism, has outpaced the development of ethical and legal governance. While these types of tourism activities, and their high risks, frequently capture public attention and media headlines, they have received limited academic scrutiny or attention on the moral and regulatory dilemmas. Though foundational work exists addressing the ethical dimensions of various forms of extreme tourism (Marsh, 2025, Marsh, 2024, Marsh, 2010, Marsh, 2006), this focus is narrow.

When most people think of extreme tourism, what likely comes to mind are forms of extreme tourism that get a lot of media attention such as space tourism, deep sea diving, and mountaineering. One form is the relatively young and unexplored field of space analogue tourism. Space analogue sites are often remote locations on Earth chosen for their geological, environmental, and operational characteristics that mimic those found on the Moon, Mars, or asteroids. These space analogue sites, often found in environments like deserts, polar regions, volcanic fields, subterranean, and underwater habitats which have historically been crucial to the scientific endeavor of

space exploration (De la Torre et al., 2024). For example, NASA's use of analogues dates back to the Apollo era, sites were for training astronauts in geology and surface operations for the Moon landing while also testing a variety of equipment (Reagan et al., 2012). Since that time, government, academic institutions (e.g., NASA, ESA), and occasional private companies, have utilized space analogues such as Biosphere 2, the Mars Desert Research Station (MDRS), and HI-SEAS in Hawaii, as well as many other dedicated facilities, to conduct critical research into astronaut training, hardware development, human factors, and psychological training with data collection performed by professional scientists and engineers (De la Torre et al., 2024).

In recent years, a type of tourism that might be best described as “space analogue tourism” has come into play. This sector adapts the operational rigor of scientific analogues into a paid, consumer experience, seeking to recreate the psychological, physical, and logistical challenges of space travel for non-scientist or less experienced crew members while providing basic training. For individuals who might never go to space due to the high cost, this can provide a less expensive, longer duration, and unique extreme tourism experience. Notable commercial ventures exemplify this trend, such as Mars-Moon Astronautics Academy & Research Science (MMAARS) which provides virtual scientific training as well as in-person analogue simulations where those skills can be honed (MMAARS, 2025) as well as the ambitious Stardust Research Station proposed by Stardust Technologies (Gemmill, 2022).

While this industry holds undeniable inspirational value, potentially fueling interest in STEM (Science, Technology, Engineering, and Mathematics), the rapid expansion, much like other extreme tourism forms, lacks a comprehensive ethical framework. The absence of such governance poses significant threats to the environment, perpetuates social inequality, and creates dangerous liabilities regarding participant well-being.

The current body of research remains deficient in addressing the broader ethical implications of related high-risk fields, particularly the commercialization of space analogue tourism. This paper contends that the long-term sustainability and legitimacy of the space analogue tourism industry depend entirely on the proactive adoption of a robust ethical framework that strictly governs environmental impact, ensures social equity in access, and prioritizes participant psychological welfare.

2. Environmental Considerations

The space analogue tourism industry is primarily based upon environments that are, paradoxically, pristine and hostile. These locations are selected precisely because they mimic the desolation of the Moon or Mars, yet they are terrestrial ecosystems that are highly sensitive to human intervention. This contradiction forms the core of the first ethical dimension: while the missions simulate off-world detachment, the physical infrastructure, logistics, and continuous presence of commercial operations impose severe, localized environmental damage and must justify the ecological cost of its existence by adhering to a standard of environmental stewardship that is significantly higher than conventional adventure tourism.

2.1 The Fragility of Analogue Sites and Biological Contamination

The ethical risks begin with the direct physical impact on the chosen analogue environments. Analogue sites are often fragile ecosystems where human intrusion, even of expert scientists, can cause slow-healing, long-term damage. For instance, in dry regions, vehicle tracks can destroy the extremely slow-growing cryptobiotic soil crusts, which are vital to soil stability and nutrient cycling, leaving scars that may persist for decades (Ramsey et al., 2025).

Beyond physical damage, risks such as terrestrial biological contamination or the introduction of diseases are significant threats. Analogue sites, particularly those containing extremophiles (microorganisms that thrive in harsh conditions) such as in the polar regions, are invaluable to astrobiologists studying the potential for life on other planets. Uncontrolled tourist activity risks introducing non-native microbes, compromising the scientific integrity of the site and potentially leading to the loss of unique ecological data. Furthermore, the selection of these sites carries an opportunity cost: once degraded by extensive commercial tourism even if basic scientific training is provided, the land may be permanently unsuitable for future, higher-priority scientific research or planetary protection studies, thereby eroding the finite pool of scientifically relevant terrestrial analogues.

2.2 Operational and Logistical Impacts

The ethical critique of environmental impact extends beyond the sites themselves to include the operational and logistical footprint of the industry. To mimic a human presence on Mars or the Moon, analogue facilities

require extensive infrastructure, such as sealed habitats, power generation systems, and waste disposal units all of which necessitate resource extraction and manufacturing, disrupting remote environments (Nelson et al., 2020). The ongoing maintenance of pressurized habitats in extreme temperatures may also create an energy demand far exceeding that of standard eco-tourism.

More significantly, the sheer distance required to move participants and support staff to isolated analogue locations may impose a substantial carbon footprint, relying heavily on air transport and ground logistics across vast, sensitive terrains. The ethical obligation is for the analogue industry to rigorously calculate, report, and offset these high emissions. This must involve moving beyond simple, theoretical carbon offsets to investing directly in local renewable energy infrastructure and sustainable logistics chains that tangibly benefit the surrounding communities and reduce the global warming impact associated with high-altitude and high-distance tourism.

2.3 Proposed Solutions and Mitigations

To mitigate these complex impacts, operators must be held to Stringent Environmental Regulations, ideally enforced by an independent, international accreditation body and tied to specific ISO standards. This should include mandating net-zero operational policies within a defined timeline, implementing strict protocols for waste management, and the prevention of biological cross-contamination. This could require the use of sterilization vestibules and mandatory equipment decontamination procedures modeled after planetary protection standards. A critical step is the establishment of comprehensive buffer zones and continuous environmental monitoring programs to track soil, water, and atmospheric changes surrounding the primary habitat. Furthermore, the industry must commit to sustainability as a core commercial principle, actively funding and executing long-term ecological restoration projects in the local communities they impact, thus ensuring that the analogue experience contributes positively to, rather than merely extracting value from, the terrestrial environment.

3. Social Equity and Access

The high-risk, high-reward nature of space analogue tourism, like most other extreme tourism adventures, creates an ethical dilemma concerning access and fairness. As a costly commercial enterprise, it threatens to transform an experience rooted in scientific collaboration and public inspiration into an exclusive commodity. The ethical responsibility here is to reconcile the profit motive with the founding principle of space exploration: that the endeavor should benefit all of humanity. Addressing this requires a direct engagement with the financial mechanisms that create barriers and a clear strategy for promoting merit-based inclusivity.

3.1 Social Equity and Access

The high financial barrier to entry for space analogue tourism, although certainly less expensive than an actual spaceflight makes it possible for middle class individuals with several thousand dollars of disposable income (MMAARS, 2025) which still leaves out those of lower socioeconomic status. This fundamentally establishes a "Pay-to-Play" model for simulated exploration. The financial barrier does not just restrict access; it raises ethical questions about the opportunity cost of diverting massive private wealth into simulated experiences when significant global challenges remain. The ethical mandate is to justify this exclusivity by demonstrating a clear, measurable public benefit. Furthermore, the industry currently lacks transparency in its selection criteria, suggesting that access is determined more by the size of one's bank account than by merit, aptitude, or commitment to scientific goals, thereby failing to reflect the diversity of human capability.

3.2 Exacerbating Existing Inequalities and Commodified Identity

This financial exclusivity deepens existing inequalities by prioritizing wealth over merit. The experiences are often marketed with language reserved for genuine discovery and heroism, commodifying the identity of the "explorer." This marginalizes those from low-income or historically underrepresented groups who lack the means but possess the intellect and passion for exploration.

The social injustice is compounded when analogue experiences are used as credentialing tools, potentially giving paying participants an unfair advantage in later scientific, military, or genuine space-related applications. An ethical framework must prevent the analogue experience from becoming an exclusive, paid form of career

gatekeeping, ensuring that the pursuit of personal adventure does not disproportionately benefit a privileged few at the expense of equitable scientific representation.

3.3 Strategies for Accessible Pathways

To address this significant ethical gap, the industry must develop Strategies for Accessible Pathways and integrate a mandatory Corporate Social Responsibility (CSR) component into its business model. This requires dedicating a minimum percentage of commercial revenue to robust, competitive subsidized programs and full scholarship opportunities. These programs must specifically target educators, emerging researchers, and members of historically underrepresented groups in STEM, based on merit and demonstrable scientific potential rather than financial capacity. Operators should also partner with national science foundations, NGOs, and educational institutions to establish community outreach partnerships that bring the educational elements of the analogue experience to underserved schools, thereby linking commercial success directly to genuine contributions toward social equity and scientific diversity. Furthermore, establishing clear criteria for merit-based participation tiers could provide pathways for exceptional individuals to join missions without bearing the full financial burden.

4. Participant Welfare and Duty of Care

The simulation of isolation, confinement, and high-stress scenarios, the very elements that make analogue tourism appealing, introduces profound ethical risks concerning participant health. Unlike professional astronauts who undergo years of preparation, commercial tourists are exposed to these intense psychological and physical stressors with significantly less training (Marsh, 2024). Therefore, the commercial operators bear an exceptionally high duty to safeguard the well-being of participants, recognizing that the pursuit of profit must never compromise human safety.

4.1 Identifying Psychological and Physical Risks in Simulated Extremity

Analogue tourism activities involve the deliberate simulation of extreme conditions, including prolonged isolation, confinement, and high-stress scenarios. These environments can trigger or exacerbate pre-existing psychological vulnerabilities, leading to issues like acute stress reactions, anxiety, depression, burnout, and behavioural conflicts within the crew (Marsh, 2007). Given the commercial sector's condensed timelines and focus on maximizing customer experience, they often lack the extended preparation phases common in government programs, thus significantly increasing the risks of a negative psychological outcome. The risks are compounded by unique, mission-specific hazards within analogue habitats, such as the potential for equipment malfunctions (e.g., gas leaks, life-support failure), severe weather, and unforeseen local environmental threats (e.g., wildlife interaction) in remote areas.

The operator's ethical responsibility must extend beyond basic liability to encompass a holistic duty of care, acknowledging the unique vulnerability that arises when simulating existential danger for commercial profit. This must address both pre-mission education and in-mission support.

A failure to provide this comprehensive duty of care constitutes ethical dereliction, demonstrating a willingness to prioritize commercial profit over human safety and well-being. While developing clear liability waivers is necessary to communicate inherent risks, these documents must not be used to absolve operators of their responsibility to implement necessary safety protocols. Accountability must be enforceable through regulatory bodies or industry-agreed standards.

4.2 Mandating Psychological Oversight and Continuous Psychological Support

Operators bear an ethical obligation to mandate rigorous and continuous oversight of their missions. This must include mandatory medical screening as well as psychological screening processes that go beyond simple questionnaires, incorporating clinical interviews, psychometric testing, and behavioural assessments modeled after stringent astronaut selection standards. The screening must explicitly aim to identify resilience traits, cognitive functioning under duress, compatibility with crew dynamics, and clear red flags for mental health instability under stress.

Crucially, when in-mission, continuous and accessible mental health support must be delivered by qualified, licensed professionals with specific experience in remote or operational psychology. This support must be

available 24/7 and provided throughout the mission via secure, private communication channels, allowing participants to seek help without fear of immediate mission termination unless safety is compromised.

Extreme tourism, whether lasting minutes or months, faces a critical regulatory void regarding medical preparedness. Although remote, high-risk environments logically require advanced medical supplies, current regulations fail to mandate a minimum standard of care. Existing safety frameworks, such as international air and sea conventions, focus primarily on operator liability for injury or death, but remain silent on required medical equipment or training onboard. This gap is glaringly evident in the commercial space sector: the 2004 Commercial Space Launch Amendments Act, for instance, places exhaustive emphasis on informed consent, requiring operators to inform participants in writing about known and unknown hazards and catastrophic failure rates, yet it specifies no mandatory medical equipment, training, or personnel requirements whatsoever (Marsh, 2006). Similarly, terrestrial extreme tourism often operates under minimal or self-imposed medical standards (Kamler, 2000, Weathers and Michaud, 2000). Given the vast differences in environments (polar, jungle, mountain), the solution is not a single rule, but a shift toward requiring professional, standardized remote care training, such as the Wilderness First Responder (WFR) or Wilderness EMT (WEMT) certification, as a minimum prerequisite for commercial extreme tourism operators.

Furthermore, pre-mission education should include detailed, realistic expectations about the psychological stressors involved, focusing on resilience training, conflict resolution, and coping strategies, ensuring genuine and fully informed consent.

This accountability should extend to Post-Mission Care, which is often overlooked. Operators should be ethically and contractually obligated to provide mandatory psychological debriefing and a period of follow-up mental health support (e.g., six months) to address potential delayed onset of symptoms, such as post-trauma stress or reintegration issues after prolonged isolation. Operators must be prepared for legal and financial liability for foreseeable harm resulting from negligence in psychological and physical risk management, ensuring that safety is the primary, non-negotiable metric of mission success.

5. Conclusion

The continued growth of the space analogue tourism industry presents a compelling opportunity to both inspire the public and generate commercial revenue, but this potential is fundamentally conditional on adhering to a robust ethical framework. The three pillars of Environmental Responsibility, Social Equity, and Participant Welfare are interdependent: damage to one pillar threatens the legitimacy of the entire enterprise. Permitting analogue tourism to degrade pristine natural environments undermines its scientific value, while limiting access solely to the wealthy erodes its societal justification. Furthermore, prioritizing profit over the psychological safety of participants demonstrates a fundamental failure of moral conduct. Ethical governance should not be viewed as an impediment to commercial success but rather as a necessary prerequisite for securing the long-term social and environmental license to operate. A collective effort involving industry leaders, regulatory bodies, and ethics scholars is required to proactively develop a standardized and enforceable ethical charter, ensuring that the dreams of off-world exploration are not pursued at the expense of our ethical duties on Earth.

Ethics Declaration

Ethics approval was not needed for this paper as it was theoretical and did not use human subjects.

AI Declaration

All ideas in this paper were created by humans however AI was used for sentence improvement and grammar correction as we did not have the time to run this through a human editor due to time constraints.

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