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Research Report

General Assembly

The Question of The Colonization of Mars



Background

Mars colonisation refers to establishing long-term, human-occupied settlements that go beyond short exploratory missions and move toward some degree of technical, economic and political self-sufficiency. In practical terms, this means building habitats, life-support systems, power generation and local production, so that settlers rely less on continuous resupply from Earth.

Today's debate builds on decades of state-led exploration. Robotic missions have gradually transformed Mars from a distant red dot into a mapped environment with measurable risks and still many uncertainties. The Viking landers in 1976 carried out early experiments searching for signs of life. Later rovers such as Spirit, Opportunity, Curiosity and Perseverance gathered strong evidence that Mars once had liquid water, while also collecting environmental and engineering data that helps scientists assess whether humans could operate there safely.

For much of the Space Age, Mars exploration was almost entirely government-led. That remains true in terms of funding and oversight, but the balance of capability has shifted. Commercial launch providers and private aerospace companies now build and operate key systems within national programmes. Some of these actors openly frame Mars as a long-term destination, which places pressure on international rules that were originally written for an era dominated by state missions.

The legal foundation remains the 1967 Outer Space Treaty (OST) and related UN instruments. Its core principles state that outer space must be used for the benefit of all countries, that celestial bodies are not subject to national appropriation, that states are internationally responsible for national activities in space, including private ones, and that harmful contamination must be avoided. The Treaty was not drafted as a detailed blueprint for permanent settlements, but its language still shapes what is legally permissible.

Planetary protection is especially relevant. Article IX of the OST requires states to avoid harmful contamination of celestial bodies and adverse changes to Earth's environment from extraterrestrial material. As human presence becomes more realistic, the tension between scientific exploration, settlement ambitions and contamination risks becomes harder to ignore.

The General Assembly is therefore addressing an issue that is no longer purely theoretical. Even if permanent settlement remains technologically difficult, early regulatory decisions about land use, resource extraction and private supervision may create precedents that are difficult to reverse later.

Definition of Key Terms

Colonisation of Mars- The establishment of long-term human settlements on Mars, supported by infrastructure for habitation and increasing autonomy from Earth-based resupply.

In-situ Resource Utilisation (ISRU)- The use of local Martian resources, including water ice, atmospheric carbon dioxide and regolith, to produce essentials such as fuel, oxygen, water and construction materials.

Outer Space Treaty (OST)- The 1967 treaty forming the foundation of international space law, including the non-appropriation principle and the requirement that states supervise non-governmental space activity.

Planetary Protection- Policies and practices designed to prevent harmful biological contamination of other worlds and to reduce risks to Earth from returned extraterrestrial material.

Non-Appropriation Principle- The OST rule stating that outer space and celestial bodies cannot be claimed as sovereign territory by any state.

Space Resource Utilisation- The extraction and use of natural resources from celestial bodies for scientific or commercial purposes, distinct from claiming territorial sovereignty.

Overview of Current Issue

Environmental Impact on Earth

A serious settlement strategy would involve repeated launches and an extensive Earth-based supply chain. Even with reusable launch systems lowering cost per flight, large-scale activity still requires manufacturing, propellant production, infrastructure expansion and raw material extraction. If activity were to scale over decades rather than remain limited to a few missions, the cumulative environmental impact could become significant.

Another concern is opportunity cost. Critics argue that sustained focus on Mars risks diverting funding and political attention away from urgent terrestrial priorities such as climate mitigation and poverty reduction. Supporters respond that exploration programmes historically generate dual-use technologies, including improvements in closed-loop recycling, energy systems, robotics and remote medicine. The debate often turns on how Mars activity is governed and whether its benefits justify its environmental and economic footprint.

Environmental Impact on Mars

Mars has immense scientific value precisely because it remains largely untouched. Evidence strongly suggests that it once had liquid water, and the possibility of past or even present microbial life has not been ruled out. Human presence carries contamination risks. Earth microbes transported on equipment, habitats or waste systems could obscure biosignatures or permanently alter local environments before they are fully studied.

Settlement would also reshape local landscapes. Construction, drilling and resource extraction would modify geology and surface conditions. Even without dramatic terraforming proposals, a permanent base would inevitably create a zone of environmental alteration. This raises governance questions about where settlement should be allowed and which regions require stricter protection for scientific research.

Governance and Legal Challenges

Under the OST, no state may claim sovereignty over Martian territory. This means that even if a nation builds and operates a base, it cannot legally declare the surrounding land as national soil. However, operational control for safety is still necessary. The challenge lies in defining safety zones or exclusive areas without allowing them to evolve into de facto territorial claims.

Private actors are not exempt from international responsibility. Article VI makes states responsible for supervising national activities in space, including those conducted by non-governmental entities. Article VIII gives states jurisdiction over their registered space objects and personnel. In a multi-national settlement, this creates complex overlap. Questions arise over which legal system applies in disputes, how environmental standards are enforced and how conflicts between jurisdictions are resolved.

Property and resource rights remain debated. Because the OST focuses on sovereignty rather than explicit resource ownership, some states interpret it as permitting ownership of extracted materials while still prohibiting territorial claims. Others argue that this risks undermining the Treaty's spirit and could allow early actors to secure practical control over high-value areas. The argument usually turns on whether resource utilisation can remain consistent with the principle that space is the province of all humankind.

For committee purposes, the key point is clear: Mars is not a legal vacuum, but its governance structure for permanent settlement is incomplete.

Economic Inequality and Access to Space

In the near term, Mars settlement would only be accessible to states with advanced space capabilities and to extremely well-funded commercial actors. Missions depend on heavy-lift launch systems, precision landing technologies, robust life-support infrastructure and autonomous surface operations.

Although the OST states that outer space should be used for the benefit of all countries, it does not define how those benefits should be shared. If ISRU becomes viable, early actors may gain technological and economic advantages that are difficult for others to match. Some states may therefore advocate for benefit-sharing mechanisms or multilateral oversight, while others may argue that predictable property and investment frameworks are necessary to make high-risk projects feasible at all.

At present, there is no meaningful Mars-based economy. Nearly all spending occurs on Earth, through government programmes or commercial contracts tied to launch, spacecraft development and research. Trade or services conducted on Mars do not yet exist. Any future Martian economy would depend on several prior waves of infrastructure and population growth.

Geopolitical Implications

Mars activity could evolve in either cooperative or competitive directions. Cooperative models already exist in international exploration partnerships and the International Space Station framework. These arrangements distribute cost and risk while encouraging transparency.

At the same time, Mars carries prestige and strategic value. If safety zones, landing sites or resource-rich regions are not governed clearly, misunderstandings could escalate into diplomatic disputes. As activity becomes more permanent and more commercially driven, transparency measures and confidence-building norms become increasingly important.

Technological Feasibility

Colonisation requires solving an interconnected set of engineering and human-systems challenges. A human Mars mission involves heavy-lift launch from Earth, orbital assembly and refuelling, interplanetary transit and reliable landing of large payloads. Launch windows open roughly every 26 months, forcing mission planning into multi-year cycles and limiting emergency return options.

Entry, descent and landing remains one of the most technically demanding problems. Mars' atmosphere is too thin for parachutes alone to land heavy payloads but too thick to ignore. Human-scale missions require advanced heat shields, supersonic retropropulsion and precise navigation. NASA assessments note that scaling from rover-sized payloads to tens of tonnes has not yet been demonstrated at the required reliability level. Precision also matters because cargo flights must land close enough to each other to support coordinated surface operations, despite

dust storms, uneven terrain and communication delays that can reach around 22 minutes one way.

Surface conditions are extreme. Average temperatures hover near -60°C , atmospheric pressure is below 1 percent of Earth's, and radiation exposure is significantly higher due to the absence of a global magnetic field. Habitats must be sealed and shielded. Over multi-year stays, elevated radiation increases long-term health risks.

Life-support systems would need to recycle air and water efficiently and operate with high reliability. Power is likely to require a combination of solar generation, storage systems and potentially nuclear fission reactors.

Human health remains an unresolved factor. Mars gravity is approximately 0.38g, and no one yet knows the long-term biological consequences of living in that environment. Experience in microgravity suggests risks to bone density, muscle mass and cardiovascular function. Psychological factors are equally important. Long-duration isolation, small crews and communication delays increase the risk of stress and conflict.

ISRU is often presented as essential for long-term viability. Extracting water ice, producing oxygen and methane from atmospheric carbon dioxide and using regolith as a building material are technically plausible in principle. However, ISRU must function as an integrated industrial system rather than a single demonstration experiment. Mining, processing, storage and maintenance must operate with redundancy and autonomy. A failure in one subsystem could cascade into others.

Relevant Countries and Organisations

United States (NASA and commercial actors, including SpaceX)

NASA's Mars Exploration Program coordinates robotic missions and long-term human mission planning. The current "Moon to Mars" strategy uses Artemis and the Lunar Gateway to test technologies relevant to deep-space travel, radiation protection and long-duration habitation. Although conceptual architectures for human missions in the 2030s and 2040s exist, they are not funded colonisation programmes.

SpaceX presents the most explicit colonisation narrative among private actors, centred on Starship and frequent launch capability with orbital refuelling. Public plans outline a progression from Earth-orbit missions to lunar operations and eventually to uncrewed cargo flights to Mars, followed by crewed missions once landing and life-support systems are proven. Timelines have shifted in recent years, reflecting technical and financial realities.

European Space Agency (ESA)

ESA's roadmap positions Mars as a long-term objective following lunar activities, emphasising robotic missions and international cooperation. Scientific exploration, particularly life-detection missions, influences the governance debate because stronger evidence of potential life would strengthen arguments for strict planetary protection zones.

China (CNSA)

China demonstrated major capability with Tianwen-1, achieving orbit, landing and rover deployment. Tianwen-3 is planned as a Mars sample-return mission. Sample return is significant because it enhances scientific understanding of geology, resources and biosignatures, all of which inform discussions about settlement feasibility and environmental risk.

Other Spacefaring States

India, the United Arab Emirates, Russia and Japan have all contributed to Mars exploration or related technologies. Even where colonisation is not a stated objective, these actors have a stake in future governance frameworks.

United Nations and Multilateral Bodies

UNOOSA and the Committee on the Peaceful Uses of Outer Space provide forums for treaty interpretation and future rule development. Although the UN does not conduct missions, it plays a central role in maintaining legitimacy and multilateral consensus.

Possible Solutions

Clarify Non-Sovereign Land Use

One option for states, through COPOUS, is to negotiate clearer guidance on operational safety zones that respect the non-appropriation principle. This could involve limits on geographic scope, transparency requirements and internationally agreed dispute-resolution procedures.

Strengthen Planetary Protection

Another approach is to designate protected scientific regions and require environmental impact assessments for major settlement activities through internationally agreed planetary-protection guidelines. Equipment sterilisation standards and waste-management rules could be adapted for long-duration human presence and periodically reviewed under UN auspices

Establish Dispute-Resolution Mechanisms

A multilateral coordination framework under UN auspices could facilitate transparency, data sharing and mediation between states and authorised private actors. While national jurisdiction would remain under the OST, common procedures for investigation and arbitration could reduce conflict

Address Equity and Access

Benefit-sharing could initially focus on scientific access, shared research data and capacity-building initiatives for emerging spacefaring and developing states. Broader redistribution mechanisms would likely require gradual negotiation as activity expands and as concrete economic benefits from Mars activity become clearer.

Adopt a Phased Development Model

A realistic pathway might move from robotic reconnaissance and sample return to short human missions, then semi-permanent research stations before larger settlements. Governance structures could evolve alongside technological maturity, with each phase triggering agreed reviews of legal, environmental and safety frameworks.

Protect Settler Rights

Long-duration settlements would create high dependency on infrastructure and return capability. Baseline protections covering labour conditions, medical oversight, informed consent and dispute procedures could help prevent exploitation. Human-rights considerations are central to long-term legitimacy and could be reflected in guidelines or model agreements for future Mars facilities.

Relevant Websites and Articles

United Nations Office for Outer Space Affairs (UNOOSA) - Space Law Treaties and Principles

Official UN overview of the Outer Space Treaty and related agreements, outlining key legal principles such as non-appropriation, state responsibility and planetary protection.

<https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html>

NASA Mars Exploration Program

Provides up-to-date information on NASA's robotic Mars missions, long-term human exploration plans and the Moon-to-Mars strategy.

<https://science.nasa.gov/planetary-science/programs/mars-exploration/>

NASA - Mars Entry, Descent and Landing (EDL) Assessment Material

Technical overview explaining the engineering challenges of landing heavy payloads on Mars, including scaling issues for human missions.

<https://www.nasa.gov/wp-content/uploads/2024/12/acr24-mars-edl-challenges.pdf>

SpaceX - Human Spaceflight and Mars

Outlines SpaceX's long-term plans for Starship, including proposed cargo and crew missions to Mars and the role of in-situ resource utilisation.

<https://www.spacex.com/humanspaceflight/mars>

European Space Agency (ESA) - Aurora Roadmap to Mars

Explains ESA's long-term exploration strategy, including robotic missions, international cooperation and future human exploration planning.

https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Exploration/Aurora_s_roadmap_to_Mars

“Towards Sustainable Horizons: A Comprehensive Blueprint for Mars Colonization” (2024)

Academic article analysing technical, environmental, socio-political and ethical considerations involved in building a sustainable Mars settlement.

<https://pmc.ncbi.nlm.nih.gov/articles/PMC10884476/>

United Nations Committee on the Peaceful Uses of Outer Space (COPUOS)

Overview of the UN body responsible for developing principles and guidelines that shape international space governance.

<https://www.unoosa.org/oosa/en/ourwork/copuos/index.html>



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