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Legal Implications of the Space Colonization and the UAE's Sustainable Approach towards Mars Mission

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Mars is the planet closest to Earth. Many support that it may house humanity in the future. On the surface of Mars, sufficient resources are available to support life. Active studies are required to fundamentally comprehend the varied operating conditions and the major governing parameters involved in the growth of space colonization and supported atmospheric conditions. The existing legal framework of the Outer Space Treaty (OST), which was designed several decades ago, describes its goal of peaceful collaboration based on principles that we have not been able to uphold on Earth. It is vital to address the gaps in the legal system and ultimately deal with the mostly unanswered legal and regulatory questions. As interest in Martians colonisation missions from both government agencies and the private sector evolves, a workable solution that respects the essence of the OST and allows for limited sovereignty claims outside of protected habitation has been proposed.

Keywords
Mars, Space Colonization, Outer Space Treaty, Sustainability, Human Settlement, Space Agencies, Private Sectors

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1. Introduction

For a long time, critics have believed that sending humans into space is a waste of money and colonizing the solar system is just a pipe dream. For instance, eminent scientist Robert Park has stated that the future is not in spacesuits.[1] Despite this belief, this study demonstrates that there are valid justifications for manned space exploration and subsequent colonization. In recent, human ability to colonize other celestial bodies in the solar system, particularly Mars, is increasing.[2] As space agencies and the private sectors are both interested in this idea, science fiction literature, film, and art are all extensively exploring it. The first stage in any colony project would be a human expedition to Mars. Landers and rovers have successfully investigated the surface of Mars and transmitted data regarding the local environment. The asteroid belt and Earth's orbit are both near Mars' one. According to the data they transmitted, the days on Mars and Earth resemble each other (Table 1), but Mars is inhospitable to life (Table 2).

Table 1: Relative Similarities between Earth and Mars[3]

	Earth	**Mars**
Day time (HH:MM:SS)	24	24:39:35
Axial Tilt (Degree)	23.44	25.19
Equilateral Radius (km)	3,396.2	6,378.1
Surface Area (km^2)	148,940,000 Land 361,132,000 Water	Doesn't exist
Atmospheric components	Nitrogen (N_2), Oxygen (O_2), Argon, Carbon dioxide (CO_2), and water vapor	Carbon dioxide (CO_2), Nitrogen (N_2), Argon, Oxygen, and water
Water	71% of its area is liquid water	Iced water were found only

1 Robert Park, *The Virtual Astronaut*, New Atlantis (Dec. 21, 2004), https://www.thenewatlantis.com/publications/the-virtual-astronaut.

2 Patrick Pester, *How Long will it Take for Humans to Colonize Another Planet?*, Live Sci. (Apr. 2, 2023), https://www.livescience.com/how-long-will-it-take-for-humans-to-colonize-another-planet.

3 Nader Sherif et al., Life on Mars 1-21 (Ain Shamns University Faculty of Engineering Report, 2008), https://www.scribd.com/document/20367821/Life-on-Mars-Final-Report.

Table 2: Relative Differences between Earth and Mars[4]

	Earth	Mars
Orbit around the Sun (days)	365.25	685.18
Surface Gravity (g)	0.997	0.376
Temperature (Kelvin)	287	227
Liquid water	Exists	Doesn't exist
Surface Pressure (kPa)	101.3	0.7 : 0.9
Atmospheric Components (%)	78.08% N_2 20.95% O_2 0.93% Argon 1% water vapor	95% CO_2 3% N_2 1.6% Argon
Magnetosphere[appendix]	Relatively stronger	Weak

Mars's average temperature varies between 94 and 32 °F (70 and 0 °C). It has an unbreathable atmosphere that is thick enough to produce wide dust storms. Also, the ionizing radiation on the planet is severe with fine dust blanketing the arid Martian surface. On Mars, there are few opportunities for producing electricity using nuclear, solar, or wind energy.[5] The risks and challenges include radiation exposure, toxic soil, low gravity, isolation brought about by Mars' separation from Earth, lack of water, and low temperatures.

However, Mars is significantly closer to Earth than any other planets in the solar system. Also, the conditions on Mars are significantly better than those on Mercury, Venus, or the outer planets and their moons, which all experience extremely hot, cold or cryogenic temperatures. Most of the natural environments on Mars have been explored by humans in Earthly settings. The hottest temperatures on Mars are comparable to the extremely cold temperatures in the Arctic and Antarctic.[6] The capacity of humans to adapt to new conditions is vital for their own survival.

The United Arab Emirates (UAE) documented a Martian colonization plan for 2117.[7] The UAE Space Agency (UAESA) has already spent more than USD 5.4 billion

4 *Id.*

5 Erik Seedhouse, Martian Outpost: The Challenges of Establishing a Human Settlement on Mars 1-77 (2009).

6 Tim Sharp & Jonathan Gordon, *What is the temperature on Mars?*, Space (Feb. 25, 2022), https://www.space.com/16907-what-is-the-temperature-of-mars.html#:~:text=The%20temperature%20on%20Mars%20is%20relatively%20low%2C%20averaging,minus%2080%20degrees%20Fahrenheit%20%28minus%2060%20degrees%20Celsius%29.

7 UAE Future 2030-2117, https://u.ae/en/more/uae-future/2030-2117#:~:text=The%20UAE%20aims%20to%20establish,

on research for its first Martian mission, the Hope Probe.[8] In 2020, the UAE became the sixth nation to send a probe to Mars. The manned journey to Mars would be the greatest adventure in human history.[9] In contrast to the Moon, Mars appears to have the environment to host the first permanent human habitat colony outside the Earth.[10] This paper is composed of the hunt for extraterrestrial life, the necessity for basic science study to learn more about the genesis and development of the solar system, and applied research on exploiting Martian resources to enhance life-sustaining systems for establishing a human settlement on Mars. It has become essential to build research colonies for vital space exploration programs due to the extensive space exploration activities. This is a potential solution to the planet's rapidly expanding population in the colonization of Mars. In addition, when applicable, a succinct comparison of the existing national and international framework and a detailed analysis of various literature has been done to identify the gaps in the current international framework.

2. Legal Implications of Humans Living Off-Earth

A. Mars Colonisation: Is It Necessary?

The colonization of Mars has gained interest in recent years because of the possibly naive and dubious assumption that this planet might one day be terraformed to support human life.[11] Most scientists, including Stephen Hawking, agree that Mars is the best planet for imminent colonization because of its habitable environment and capacity to change into a stable ecosystem in the far future.[12] Mars is believed to provide a hypothetically far more hospitable environment for colonists from Earth than any nearby planet because of its radius of 0.53 times that of Earth, with a surface area nearly equal to the whole area of dry land on our planet, and its surface gravity

year%20plan%20for%20its%20implementation.

8 Ann Simmons, *The United Arab Emirates launches a plan to colonize Mars by 2117*, L.A. Times (May 31, 2017), https://www.latimes.com/world/la-fg-uae-space-20170531-story.html.

9 Adam Morton, Should We Colonize Other Planets? 1-40 (2015).

10 W. Lambright, Why Mars: NASA and the Politics of Space Exploration 50-73 (2011).

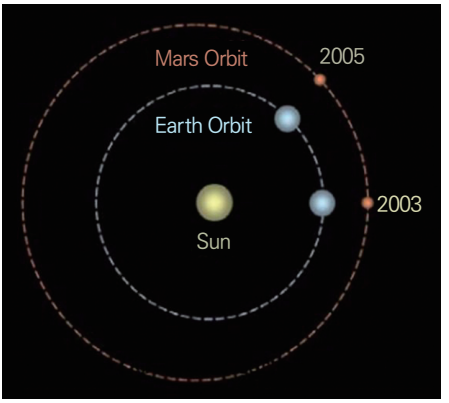
11 Robin Wordsworth et al., *Enabling Martian Habitability with Silica Aerogel Via the Solid-State Greenhouse Effect*, 3 Nature Astronomy 898-903 (2019); Bruce Jakosky & Christopher Edwards, *Inventory of CO2 Available for Terraforming Mars*, 2 Nature Astronomy 634-9 (2018).

12 Arjun Kharpal, *Stephen Hawking Says Humans must Colonize Another Planet in 100 years or Face Extinction*, CNBC (May 5, 2017), https://www.cnbc.com/2017/05/05/stephen-hawking-human-extinction-colonize-planet.html.

of 0.38 times that of Earth.[13] Furthermore, low radar frequencies on the Mars Express spacecraft have long supported the idea that subsurface and subglacial liquid water may be accessible.[14]

There are two alternatives regarding traveling to Mars. The first option is to visit Mars which is 56 million kilometres from Earth. This choice is lighter because it requires less fuel. However, astronauts can only return to Earth after the two planets are once again close to each other, which only occurs after 18 months. (Figure 1)

Figure 1: Earth and Mars both orbit the sun in distinct orbits and at varying speeds



Therefore, they would have to spend 18 months on a hostile and deadly planet. The second option, which is riskier, is a short-stay mission. The spacecraft passes past Venus and uses the gravity of the planet as a slingshot to conserve fuel. However, the window to reaching Venus is limited; if the astronauts miss it, they cannot return. The most secure option is thus to travel directly to Mars and return in the shortest amount of time with the least amount of fuel. Nuclear energy is the most suitable available fuel.[15]

With a wide variety of perspectives, there is undoubtedly an agreement that Martian colonization is necessary or even feasible.[16] Orwig offers five justifications for settlement on Mars, inferring that building a permanent habitable colony on Mars

13 Matt Williams, Mars Compared to Earth, Phys.Org (Dec. 7, 2015), https://phys.org/news/2015-12-mars-earth.html.

14 R. Orosei et al., *Radar Evidence Of Subglacial Liquid Water On Mars*, 361(6401) Sci. 490-3 (2018).

15 Apple TV+, Journey to the Red Planet (2007), https://tv.apple.com/gb/episode/journeytothredplanet/umc.cmc.opksngnax4zbzqsgy1axd2qz?showId=umc.cmc.2vm9bzsz5erkasjqe7o8w9pst.

16 Jessica Orwig, *5 Undeniable Reasons Humans Need to Colonize Mars - Even though It's Going to Cost Billions*, Bus. Insider (Apr. 21, 2015), https://www.businessinsider.com/5-undeniable-reasons-why-humans-should-go-to-mars-2015-4.

is not an elongated choice but a genuine necessity.[17] The justification are as follows:

1. The continued existence of the human species;
2. The possibility that life exists on Mars;
3. The application of space technology to improve our quality of life;
4. Evolving into an independent species; and
5. Taking the initiative in politics and economy.

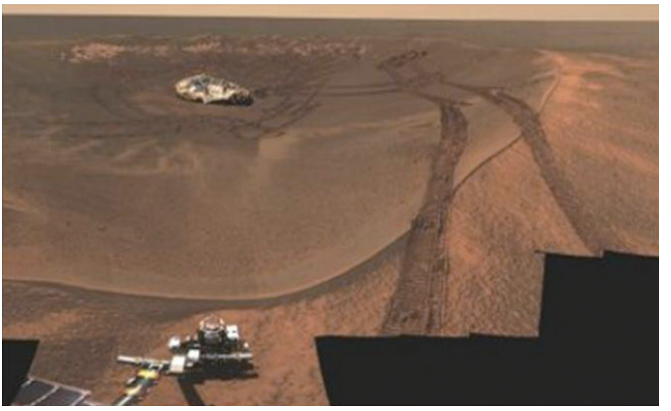
First, the possibility of colonizing other planets may increase the likelihood of human survival. Second, even a tiny population of colonists requires a constant flow of sustenance and essential materials. Third, technological advancements in the exploration of space may be possible while attempting to colonize Mars. Last, the Martian colonization could be a chance for humanity to advance a civilization and actively alter the interactions and uses of our environment.

In conclusion, the colonization of Mars presents formidable challenges. We should first travel to Mars, orbit it, and then safely return to Earth as we did with the early Moon expeditions. Following this mission, we should send people there, to analyze and investigate Mars, and to return them safely once ensuring that this can be done consistently. There are many opportunities for the private sector to contribute to this achievement, and global collaborations play significant roles in the epic journey.

B. Probable Locations for Colonies

Choosing the location to establish a colony is challenging.

Figure 2: Eagle Crater, as seen from Opportunity Source



17 Linda Billings, *Should Humans Colonize Mars? No*, 17(3) Theology & Sci. 341-6 (2019).

As illustrated in Figure 2, for instance, scientists have probed into several sites on the surface of Mars for human settlement as follows.[18]

• Polar Regions: Polar ice covers the north and south poles of Mars, which fluctuate seasonally and have long been observed using telescopes on Earth. The area closest to the North Pole has the highest water content.

• Equatorial Regions: Mars Odyssey discovered a natural cave near the Arsia Mons Volcano. The ground of the caves is thought to contain ice, water and geothermal energy. Both ice reservoirs and radiation bunkers may be useful for colonists.

• Midlands: Spirit and Opportunity, the two Mars Exploration Rovers, have encountered drastically varied soil and rock types. As a result, it can be inferred that the Martian landscape is highly diverse, and the best place for a colony can be identified once additional information is available.

• Valles Marineris: At over 3,000 km in length and an average depth of 8 km, Valles Marineris is known as the "Grand Canyon" of Mars. The atmospheric pressure is approximately 25% higher at the bottom than on the surface. As the canyon runs from east to west, solar energy collection should not be significantly hindered by the shadows cast by its walls.

Furthermore, similar to Earth, Mars is expected to contain an abundance of mineral resources both at and below its surface, with newly verified indications for minerals and other vital metal components.[19] Mars features, notwithstanding the obvious immediate problems posed by an atmosphere rich in carbon dioxide and dust, have decisively secured the planet's place as the last viable option for space colonization.[20] International space organizations and, more recently, the private sector have been working tirelessly to bring us closer to having the technological capability to deploy a limited number of people and equipment to Mars.[21] Proponents of Martians colonization believe that space technology is quickly reaching the stage where it can offer the kind of dependability and efficiency required for one-way travel from Earth

18 David Shiga, *Stephen Hawking Calls for Moon and Mars Colonies*, New Scientist (Apr. 21, 2008), https://www.newscientist.com/article/dn13748-stephen-hawking-calls-for-moon-and-mars-colonies.

19 R. Brasser & S. Mojzsis, *A Colossal Impact Enriched Mars' Mantle with Noble Metals*, 44 Geophys. Res. Lett. 5978-85 (2017).

20 F. Martín-Torres et al., *Transient Liquid Water and Water Activity at Gale Crater on Mars*, 5(8) Nature Geosci. 357-61 (2015); Ryuki Hyodo & Tomohiro Usui, *Searching for Life on Mars and Its Moons*, 373(6556) Nature Geosci. 742 (2021).

21 Davian Ho et al., *Towards an Extension of Equivalent System Mass for Human Exploration Missions on Mars*, 8 NPJ Microgravity 30 (2020).

to Mars.

The current successful firing of Voyager 1's thrusters after 37 years in orbit[22] demonstrates that humans are capable of overcoming significant challenges in spacecraft development[23] including those related to longevity, dependability and operational readiness decades after launch.[24] The affordability of small spacecrafts has made space exploration possible, allowing space agencies, academic institutions, and the private sector to gather crucial knowledge about the celestial environments in which spacecraft and humans must function to guide, thereby informing the creation of colonization programs.[25]

3. Existing Legal Framework for Space Colonies

A. Current Legal Framework

Outer space is not *terra nullius*, but *res communis*. It the common property of all people, not as the territory belonging to someone. Therefore, states are not allowed to buy or appropriate any portion of it, including celestial bodies. A challenge is to create a permanent human habitat outside Earth's atmosphere under this principle of non-appropriation. The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty: OST)[26] is currently the primary instrument governing global cooperation and communication in space and other celestial bodies. The OST provides a legal foundation for all space activities including stations, installations, outposts, and settlements. All existing spacefaring states have ratified the OST. Article I of the OST allows governments to 'use' space, which technically would mean sending people to colonize Mars, provided that the habitat is preserved for the "benefit and interests of all countries." While it is true that neither "station" nor "installation" has a

22 Caltech Jet Propulsion Laboratory, *Voyager 1 Fires Up Thrusters After 37 Years*, News (Dec. 1, 2017), https://www.jpl.nasa.gov/news/voyager-1-fires-up-thrusters-after-37-years.

23 Igor Levchenko et al., *Space Micropropulsion Systems for Cubesats and Small Satellites: From Proximate Targets to Furthermost Frontiers*, 5(1) Applied Physics Rev. 1-37 (2018).

24 Brigitte Zypries, *Space, the Public, and Politics*, 41 Space Pol'y 73-4 (2017); Naoko Kishi, *Management Analysis for the Space Industry*, 39-40 Space Pol'y 1-6 (2017).

25 Hideki Takenaka et al., *Satellite-to-ground Quantum Communication Using a 50-kg-class Micro-satellite*, 11 Nature Photonics 502-8 (2017).

26 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/outerspacetreaty.html.

specified definition, Article XII of the OST implies that the terms have a more general meaning rather than a more restricted and particular one. In conclusion, the drafters of the OST might not define "station installations, equipment and space vehicles" under the concept of "freedom of use" laid down in Article I of the OST.

Nonetheless, "outer space shall be the province of all mankind" and "celestial bodies [are] not subject to national appropriation" are also stated in Article II of the OST. The ability to create any human habitat on Mars in a way consistent with these legal precepts will thus determine its legitimacy. Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty under Article II. It clarifies that all space is globally common and no state has the right to govern any part of it, even celestial bodies. A "celestial body" was first defined in 2006 by the International Astronomical Union (IAU). The IAU 2006 General Assembly agreed that a "planet" is defined as a celestial body that: "(a) is in orbit around the Sun; (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape; and (c) has cleared the neighbourhood around its orbit."[27] Outer space lawyers have always supported the idea that celestial bodies should remain under national ownership, authority, and governance.[28] Also, the UN Secretary-General should be notified when a space station begins construction.[29] Subsequently, the state supplying the station's components or where the spacecraft is registered would have the only legal authority over these components.

In this regard, the application of the "space object concept" in real life has been recognized as one potential "solution." The outer space treaties do not define a "space object" precisely. Based on current practice, however, it may be defined as a "human-made object launched into outer space."[30] Given this customary concept, everything is regarded as a "space object" from the tiniest nanosats to portions of the International Space Station (ISS), which is seen as a collection of space objects rather than a single celestial object. All stations, outposts, installations, and settlements are built from space objects because they must function in a sealed, pressurized environment (similar to the ISS). In light of this, claiming "territory" on Mars, the Moon, or any other celestial

27 International Astronomical Union, IAU 2006 General Assembly: Result of the IAU Resolution votes, at 1-4, https://www.iau.org/static/archives/releases/pdf/iau0603.pdf.

28 Bin Cheng, Studies in International Space Law 382-424 (1997).

29 UNOOSA, United Nations Register of Objects Launched into Outer Space, https://www.unoosa.org/oosa/en/spaceobjectregister/index.html#:~:text=To%20date%20approximately%2088%25%20of,registered%20with%20the%20Secretary%2DGeneral.

30 Thomas Cheney, *Space Settlement Governance: An Overview of Legal and Policy Issues* 5-10 (Centre for a Spacefaring Civilization Report, 2018), https://d22xde9k87c4ut.cloudfront.net/assets/reports/Sss4AoM9dbDYgYZHG.pdf.

body is not necessary because any station, installation, outpost, or settlement may be viewed as merely a space object.[31]

The circumstances that give rise to the call for "exclusion" or "safety" zones may be addressed by Article VII of the OST and the Liability Convention,[32] as well as Article IX of the OST, which forbids "harmful interference" with the activities of other States Parties. The outer space treaties include clauses (such as the Rescue Agreement[33] and Article V of the OST) that address astronaut rescue and return and characteristic these activities as "envoys of mankind." Nevertheless, neither the rescue nor return requirements diverge significantly from the universal human rights that demand helping those in need. However, the designation of "envoy of mankind" has little practical significance and does not confer diplomatic standing on "astronauts."[34]

The OST does not forbid colonizing Mars, but establishing a permanent settlement will undoubtedly necessitate additional laws and regulations for the potential colonists' countries of origin. If considering the main space-faring nations have not signed the Moon Treaty so far, the successful mission of the Mars colonization is also dubious. Among the UN's outer space-related activities, there are public discussions on this issue.[35] Regarding existing sovereignty, Antarctic outposts run by Antarctic claimant states would be the closest analogues to future Martian headquarters. Even in this case, however, there should be additional legislation. States can "land spacecraft on celestial bodies, collect materials and leave equipment behind, but none of these actions extends or enhances [their] rights over any part of that body" with any legal effect.[36] Art IV of the OST recognizes the freedom to establish facilities, stations, and other installations for the investigating of space and celestial bodies. Although scholars disagree as to whether this ban also applies to taking advantage of the mineral assets on celestial surfaces,[37] the concept of non-appropriation precludes the possibility of nations enlarging their boundaries by space investigation and

31 Thomas Cheney, *Developing and Adapting Space Law to Govern Long Term and Permanent Human Settlement of Outer Space, the Moon and Other Celestial Bodies*, 61 Proc. Int'l Inst. Space L. 959 (2018).

32 Convention on International Liability for Damage Caused by Space Objects, https://www.faa.gov/about/office_org/headquarters_offices/ast/media/Conv_International_Liab_Damage.pdf.

33 Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introrescueagreement.html.

34 Nina-Louisa Remuss, *Astronauts: From Envoys of Mankind to Combatants*, *in* Humans in Outer Space - Interdisciplinary Perspectives 39-56 (Ulrike Landfester et al. eds., 2011).

35 Werner Balogh, *Space Activities in the United Nations System - Status and Perspectives of Inter-agency Coordination of Outer Space Activities*, 65(1) Acta Astronautica 18-26 (2009).

36 Joshua Fitzmaurice & Stacey Henderson, *On the Legality of Mars Colonisation*, 40(3) Adelaide L. Rev. 841-56 (2019).

37 John Wrench, *Non-Appropriation, No Problem: The Outer Space Treaty Is Ready for Asteroid Mining*, 51(1) Case W. Res. J. Int'l L. 437 (2019).

developing human habitats on other planets. As of today, the existing legal framework is rather vague and seemingly outdated. However, ever-accelerating commercial ambitions have created an urgent need for serious efforts to fill the gaps in the current legal framework.

4. The UAE's Sustainability Approach towards the Mars Mission

A. Getting to Mars

A cabinet retreat in the UAE at the end of 2013 gave rise to the concept of a UAE expedition to Mars.[38] The goal of the mission, which was revealed in July 2014 by the then UAE President Sheikh Khalifa bin Zayed Al Nahyan, aims to advance our understanding of the Martian environment. Finally, His Highness Sheikh Mohammed Bin Rashid Al Maktoum gave the Arabic name Amal ("hope" in English) to the spacecraft orbiting Mars.[39] The Mars Hope Probe was created to provide information that closes knowledge gaps, particularly regarding the climate and atmosphere of Mars. Mars Hope will produce the first accurate 24-hour image of the climate on Mars throughout the Martian year, building on the findings of the National Aeronautics and Space Administration (NASA) Maven Mission.[40]

Meanwhile, the Emirates Mars Mission (EMM) of the Mohammed bin Rashid Space Centre (MBRSC) is a prime illustration of the strength of collaboration in space which was conducted by the MBRSC in the UAE with several US research institutions, including the Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado Boulder, Arizona State University and the Space Sciences Lab (SSL) at the University of California-Berkeley (UCB).[41] On July 19, 2020, Mitsubishi Heavy Industries finally launched the Hope Probe using a Japanese H-IIA

38 Elizabeth Gibney, *How a Small Arab Nation Built a Mars Mission from Scratch in Six Years*, Nature (July 8, 2020), https://www.nature.com/immersive/d41586-020-01862-z/index.html.

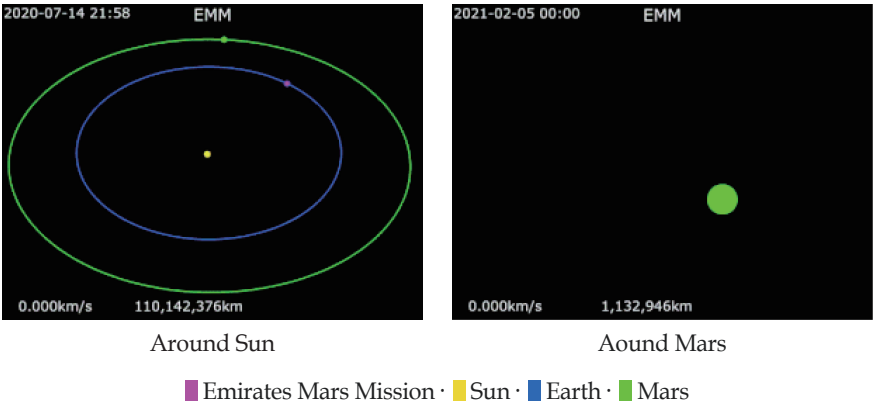
39 Brian Berger, *UAE Unveils Science Goals for 'Hope' Mars Probe*, Space News (May 6, 2015), https://spacenews.com/uae-positions-2020-mars-probe-as-catalyst-for-a-new-generation-of-arab-scientists-and-engineers.

40 H. Amiri et al., *The Emirates Mars Mission*, 218(4) Space Sci. Rev. 1-46 (2022).

41 Ken Hutchison, *Emirates Mars Mission Launched July 19th in Partnership with LASP at CU Boulder*, LASP News (July 14, 2020), https://lasp.colorado.edu/2020/07/14/emirates-mars-mission-launching-this-week-in-partnership-with-lasp-at-cu-boulder; Adam Schreck, *UAE to Explore Mars' Atmosphere with Probe Named 'Hope'*, AP News (May 6, 2015), https://web.archive.org/web/20150509000206/http://apnews.excite.com/article/20150506/ml--emirates-mars_mission-a48c414829.html; Rory Jones & Nicolas Parasie, *U.A.E. Plans to Launch Mars Probe*, Wall St. J. (May 7, 2015), https://www.wsj.com/articles/u-a-e-plans-to-launch-mars-probe-1430935661.

rocket. The Hope Probe took approximately 200 days to complete its 493,106 km (306,106 miles) trip.[42] It first entered a 40-hour orbit upon arrival[43] and performed a periapsis raising manoeuvre to enter a final orbit of 55 hours (just over two Martian days). There, it will spend the next two years' studying the Martian atmosphere as its instruments aid in the construction of comprehensive models.[44] The Hope Probe landed on Mars on February 9, 2021. To support the UAESA in the EMM, the Indian Space Research Organization and the UAESA organized a collaborative working group.[45] Furthermore, the mission may be extended for a third year after the expected two-year duration. The UAESA will share the first-ever global image of weather and atmospheric conditions on Mars with the scientific community worldwide as a result of the EMM.

Figure 3: Animation of EMM[46]



B. A City on Mars

The Mars 2117 strategy of the UAE is a 100-year's international collaboration to find a livable and sustainable metropolis on Mars. The science team at the MBRSC tries

42 Amiri et al., *supra* note 40.

43 Jonathan Amos, *Emirates Mars Mission: Hope Spacecraft Enters Orbit*, BBC News (Feb. 9, 2021), https://www.bbc.com/news/science-environment-55998848.

44 *UAE Unveils Details of UAE Mars Mission*, Gulf News (May 6, 2015), https://gulfnews.com/uae/government/uae-unveils-details-of-uae-mars-mission-1.1505710.

45 Huma Siddiqui, *Big Thumbs up for India! ISRO to Work with UAE for Its First Spacecraft "Hope Probe" Launch*, Fin. Express (Aug. 20, 2019), https://www.financialexpress.com/life/science-big-thumbs-up-for-india-isro-to-help-uae-launch-its-first-spacecraft-hope-probe-1680757.

46 A. Jones et al., *The Emirates Exploration Imager (EXI) Instrument on the Emirates Mars Mission (EMM) Hope Mission*, 217(81) Space Sci. Rev. 1-56 (2021).

to address some of the current day-to-day issues that the UAE faces on the route to resolving numerous issues of habitat, sustainability, and life support. These, in particular, focus on the security of three fundamental pillars: energy, water, and food. The team intends to help avoid the scenario where humankind will eventually have to migrate to Mars out of damaged the Earth beyond repair. The team tries to obtain a better understanding how to make a system to maximize yields and decrease environmental damage.[47]

Dubai revealed its intention to create an initial human settlement community on Mars before 2117. The UAE's authoritarian legitimacy is mostly dependent on loans, as demonstrated by Mars 2117. The UAE uses the future as collateral for its current political framework and as a safeguard against the anticipated arrival of a particular population, geographic position, and physical infrastructure. By Mars 2117, the UAE is willing to set up an "anticipatory authoritarianism" society that has no political inconsistencies and environmental constraints.

C. UAE Mars SDG Program

The UN adopted the "2030 Agenda for Sustainable Development" in 2015. This provides a new framework for development and requires nations to achieve the 17 Sustainable Development Goals (SDGs) that are inclusive, socially responsible, and environmentally friendly, shifting emphasis away from gross domestic product and economic growth as indicators of success and prosperity.[48] To achieve its extraterrestrial goals, the UAE is taking advantage of its strategic location on the southern edge of the Arabian Gulf, making it a potential candidate for future spaceports. The long-term Mars 2117 initiative will also give the UAE competitive advantages, such as increased soft power, scientific credibility, economic and social advantages, competitive gender balance and sustainability.[49]

In addition to formulating tactical measures for the lunar and Martian roadmaps, outer space specialists were discussing the appropriateness of the SDGs for the space sector. The most significant SDGs in the context of outer space development, according to the UAE and other international responders, are Quality Education (SDG 4); Industry, Innovation and Infrastructure (SDG 9); and the Partnership of

47 Rick Tumlinson, *There could be a city on Mars within 100 years*, Nat'l News (May 29, 2020), https://www.thenationalnews.com/opinion/comment/there-could-be-a-city-on-mars-within-100-years-1.1025953; Sarwat Nasir, *Simulation of UAE's Mars 2117 City to be Built in the Metaverse*, Nat'l News (Sept. 21, 2022), https://www.thenationalnews.com/uae/uae-in-space/2022/09/21/simulation-of-uaes-mars-2117-city-to-be-built-in-the-metaverse.

48 UNDESA, Sustainable Development Goals, https://sdgs.un.org/goals.

49 Mohammed Bin Rashid Space Centre, The Race To Space 98-127 (2019).

the Goals (SDG 17). Experts from the UAE, believe that deep space exploration will have a positive impact on these three Sustainable Development Goals (Figure 7), while experts from the Rest of World are more cautious in their impact assessment (Figure 8).[50]

Figure 4: UAE Views about Deep Space Space Mission and the UN SDGs[51]

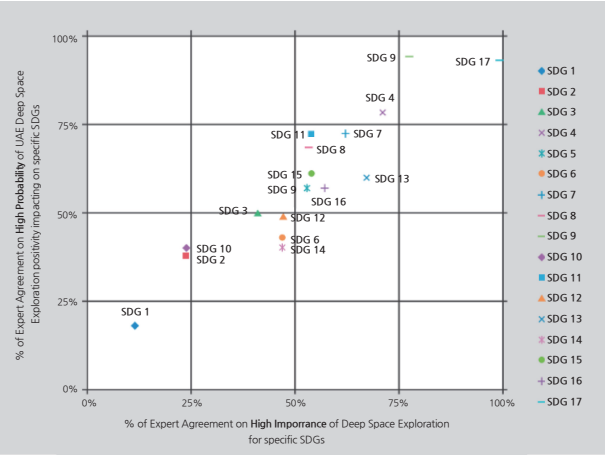
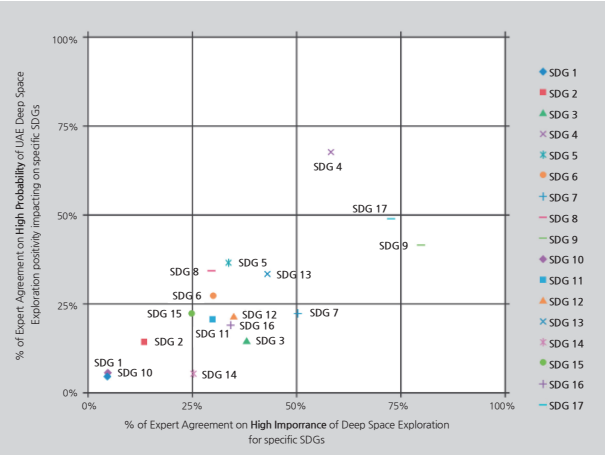


Figure 5: Rest of the World's views about Deep Mission and the UN SDGs[52]



50 Rafael Popper et al., Towards a Roadmap for Future UAE Deep Space Missions and the Sustainable Settlement of Humans on Mars: White Paper 1-58 (2020).

51 *Id.*

52 *Id.*

Surprisingly, 67% of the respondents strongly agreed that the SDGs should better integrate deep space missions to the Moon and Mars because existing missions exclusively focus on Earth.[53] Therefore, it was recommended that the UN formulate a new SDG with a specific focus on space-related challenges. This new goal would be termed "SDG 18 on the responsible exploration and use of Space."[54] It is thus significant for the UAE to spearhead a UN initiative to formulate the 18th SDG.[55]

5. Conclusion

Considering that the Earth's resources are depleting, the initial expedition to Mars should be designed to identify the necessary resources that might later be delivered back to Earth. Both the NASA and the European Space Agency have stated that no Martian missions will begin before 2025, and it is critical to conduct research in a variety of fields to prepare the Martianauts for the unusual and unknown challenges they will encounter in their hyperbaric habitations on Mars.[56] Mars stands out among the planets in our solar system because all the elements required to develop life are present on its surface in some usable form. Mars is the greatest option for establishing the first self-sufficient human settlement off Earth because it can support human life on a large scale. Mars is approximately half the Earth's size with roughly the same proportion of dry areas. Humans can tolerate its high temperatures and gravity. Furthermore, Mars has abundant frozen carbon dioxide resources, which can be used to produce the vital fuels helium-3, deuterium, and oxygen. Now, liquid water is believed to exist below the surface of the planet which can be utilized for irrigation in agriculture and its oxygenating properties. Moreover, Mars is the only planet with a 24-hour day, which may enable greenhouses to produce gases necessary for human life. Therefore, future Martian missions will increase our understanding of the mineralogy of the Martian crust, that constitute the atmosphere and particulars of the Martian environment. Earth-based research should continue to create and test components, systems and other elements to establish habitats on Mars.

53 Centre, *supra* note 49.

54 Popper et al., *supra* note 50.

55 *Id.*

56 Jack Kiraly, How do NASA and ESA work together? Planetary Society (Apr. 4, 2024), https://www.planetary.org/articles/how-do-nasa-and-esa-work-together.

In response to the growing interest in Mars colonization missions from both government space agencies and the private sector, in this research, we have proposed a workable alternative that permits limited sovereignty claims outside protected planetary parks while upholding the spirit of the OST. Scientists will determine the boundaries and regulations for planetary parks. If private and governmental organizations may colonize a small portion of Mars's surface, these entities will be in charge of their territories according to the rules of their respective home countries. While conducting scientific studies, they may even begin commercial resource exploitation missions. The Mars Secretariat will serve as the administrative body that promotes communication between the colonies. Disagreements can be settled through negotiations and a temporary tribunal made up of representatives from nearby Martian settlements.

The laws regulating state sovereignty on Mars, or any other planetary body would not apply to human settlements in the same way as they do on Earth. To fill these gaps, laws and regulations are necessary to control human habitation on Mars. Before the first human habitat is built, several important questions must be answered including who will be in charge of running the settlement and ensuring the safety and security of its occupants, if there is no responsible sovereign state. The response to this query is contingent on whether and how the global community is capable of finding a solution to the complicated problem of property rights that would function in long-term human settlements in outer space. A human habitat on Mars would not be subject to the conventional understanding of property rights found on Earth. It is imperative to differentiate between the Martian surface where those artefacts are located and space objects, as specified in Article VIII of the OST. No one can possess outer space, even though some people have attempted to purportedly buy land on the Moon and Mars and stake claims to orbits. People, governments and private companies might own a base, habitat, or pod on Mars, but they would not be able to own the land.

As a workable colonization plan, we have supported the idea to easing the constraints on sovereign claims in the updated OST. We do not question the importance of any OST provision in upholding the ideal of respect for heavenly body respect and maintaining international cooperation. Addressing interplanetary governance is relevant given that humans are presently in orbit around Earth on the ISS and there are plans to return humans to Mars. Several hypothesized Martian constitutions are based on earthly patterns. Because there is a significant degree of uncertainty around the predicted rewards, the potential for private profit is a crucial motivator for space exploration advancement. In this vein, the UAE's Mars 2117

initiative is more significant than ever.

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