United Nations / China 2nd Global Partnership Workshop on Space Exploration and Innovation
Hosts: United Nations Office for Outer Space Affairs (UNOOSA) &
China National Space Administration (CNSA)
Date: 21-24 November 2022

THE VITALITY OF LUNAR EXPLORATION FOR ALL DEEP SPACE HUMAN MISSIONS:

THE SOCIO-ECONOMIC BENEFITS

Funmilola Oluwafemi[a]* and Ropo Olubiyi[b]
[a]Space Life Sciences Division, Space Physical and Life Sciences Department, National Space Research and Development Agency (NASRDA), Km 17 Airport Road, Abuja, Nigeria.
[b]Planning Policy and Research (PPR) Department, National Space Research and Development Agency (NASRDA), Km 17 Airport Road, Abuja, Nigeria.
***Correspondence:** oluwafemifunmilola@gmail.com ; **Orcid ID: 0000-0001-7575-9992**

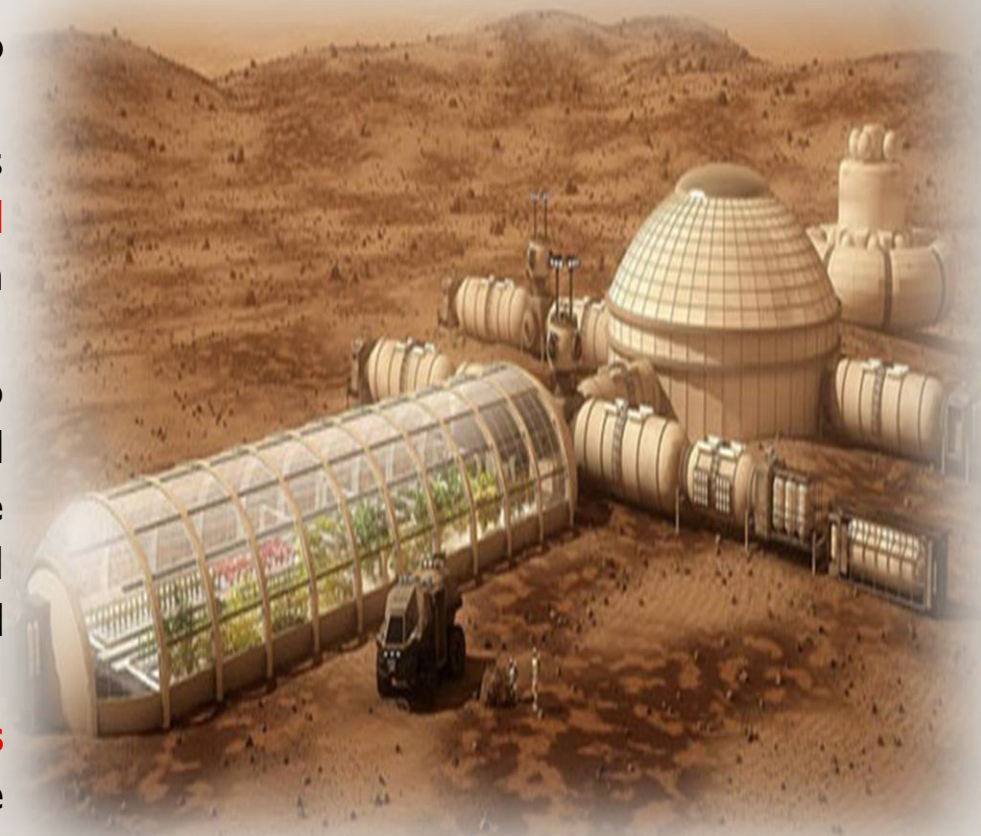
WHY SPACE EXPLORATION/MISSIONS?

- **By 2050 the UN predicts numerous challenges, among which are:** *- increased **human population***
  *- growing **pressures on environment; sanitation, climate change***
  *- shortage in **global food supplies***
  *- intense **energy demand***
- **In five billion years; Sun enters its red giant phase.**
- **Exploring the space may result on some benefits e.g. scientific, tourism**
- **Although the Moon is nearer, Mars is predicted to be able to sustain life.**

  *-Preliminary work started 1950s; planned missions typically **10 to 30 years** in the future.*
  *-**Robotic exploration** has started (Fred, 2005).*
  *-Trip to the Mars will take about **3 years** (https://www.nasa.gov/hrp/bodyinspace)*

WHY SPACE EXPLORATION/MISSIONS? CONT'D

- There are **political, scientific and cultural imperatives** contributing to the drive into the exploration of the outer space beyond the earth.
- The **cultural importance** is in the necessity of mankind to expand its border by moving farther, and having a **perception of advancement and common achievement**. The existence nature which is general to human species allows this urge to explore.
- The most crucial in the **scientific aspect** from mankind's desire is to comprehend its environment, either to meet the need of **natural inquisitiveness; benefit from substantial gain; or to remove unknown fear**. This can be an alternative exhibition of the central distinctiveness of human species, since observation, experimentation and scientific believe are very well documented all through the recorded past.
- It is well established that **specific central and fascinating questions about our origins** will only be answered by certain observations in the extreme outer space, and by the study of the solar system environs.

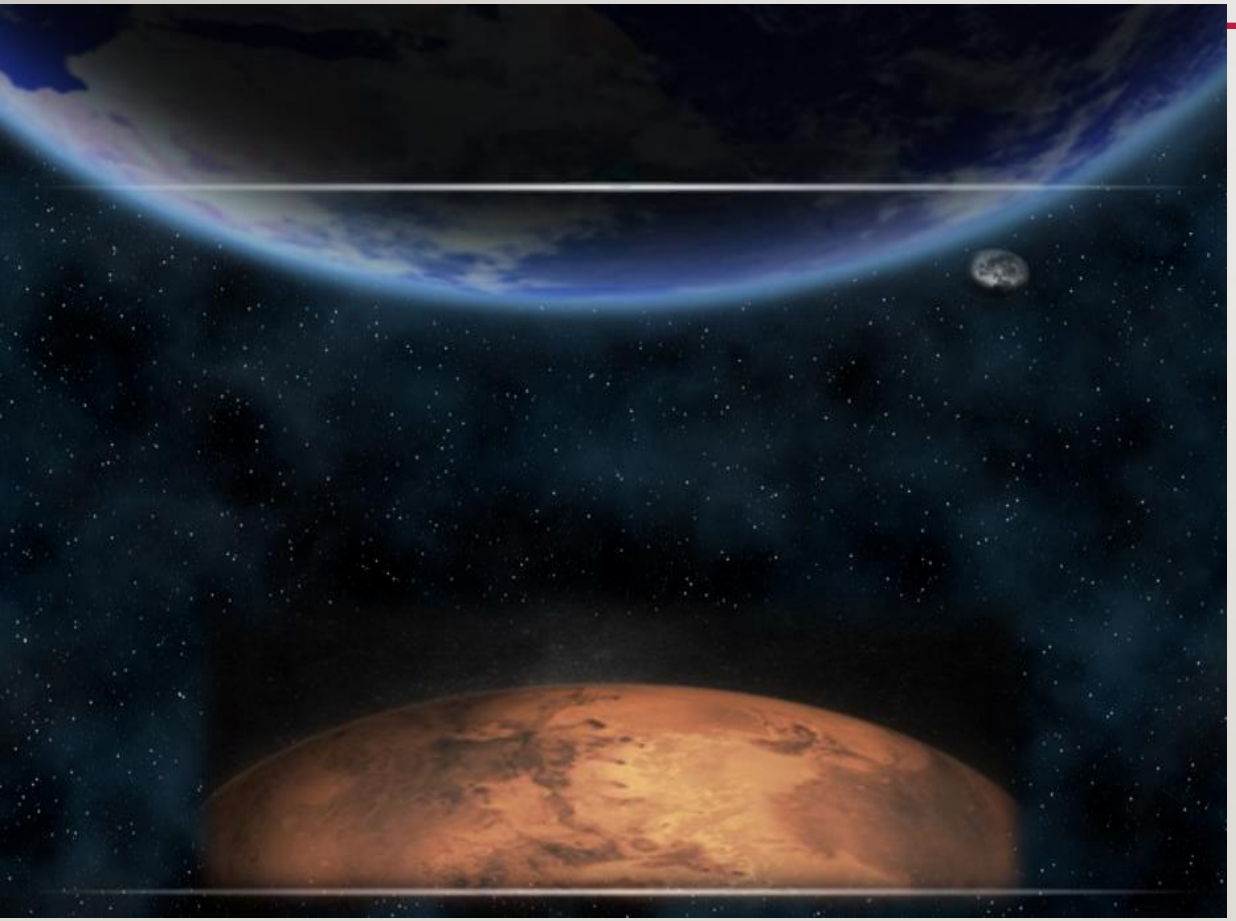


ONE-WAY MISSION

- Due to **less mass at launch and lower initial costs**, a one-way mission to the **moon, Mars, Venus**, or any other celestial body is advocated for more than a round-trip mission.
- A one-way mission means **not involving a return of the crew to the earth** (Oluwafemi et al., 2018). This could help mankind reach these celestial bodies earlier.
- A one-way mission will however entail a different approach to design the habitat modules which will **present more risks**.

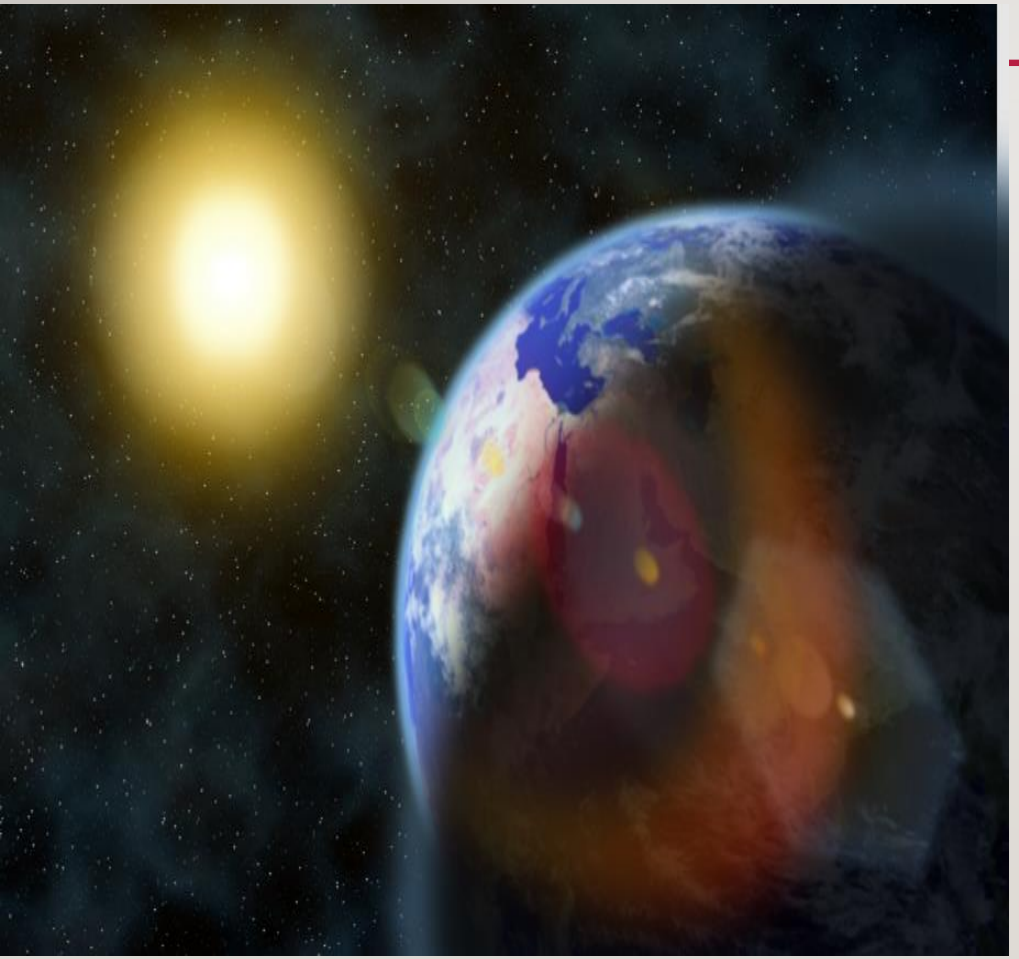

Why the Moon?
What has been done?
Why manned?

LUNAR STATION FOR DEEP SPACE HUMAN MISSIONS



- The moon is our nearest celestial neighbor; and the current interest in long-duration and planetary space exploration to Mars as an example requires further researches and understanding on self-sustaining societies.
- Moon is a possible platform for such studies.
- Consequently, the moon is vital for future human space exploration for all deep space human missions.
- The Moon is close to the Earth; therefore the Moon is considered a significant step after the Earth's orbit. On average, 384,400 km is the distance from the Earth to the Moon.
- The mission crew will be able to conduct research of scientific nature; develop and identify resources; increase experience setting-up human bases on other celestial bodies; and authenticate procedures for the investigation of further distant stations.
- A lunar station will be beneficial for trial methods for making a planetary habitat using the **resources present on the Moon** and **reducing the resources that will be imported from Earth**. This will therefore be a good preparatory stage or a **training podium for Martian habitats and other deep space missions**.
- AS a decision is made to include the Moon for manned exploration mission, it would be great to highlight communal plan so that the developments can also serve other imminent destinations.
- The average distance between the Mars and the Earth is 225 million km taking about 150 to 300 days depending on the travel path, launch speed and the position of Mars to Earth.

LUNAR STATION FOR DEEP SPACE HUMAN MISSIONS CONT'D



- ✓ If the in-situ resources are truly present and at reach; they can be made into more useful materials on the lunar surface and transported to an important and more appropriate location of departure in space (e.g. high Earth orbit or a liberation point) for interplanetary trajectories than the Moon.

- ✓ Specifically, the making of a chemical propulsion system for Moon descent or ascent, on-orbit **refueling, surface refueling, precision or smart landing systems, light weight habitats and surface mobility systems** can aid as antecedents for Mars mission.

- ✓ Some in situ materials that could be used on the Moon includes hydrogen, radioactive isotopes and water.

- ✓ It is known that the lunar surface has surplus oxygen. There is also a good quantity of hydrogen close to the Moon's poles likely in water form, as disclosed by Lunar Prospector mission. Oxygen and hydrogen together too are extremely valuable. Cryogenic hydrogen and oxygen are useable to produce the best performance bi-propellant systems that is a chemical and useable for human missions. The finding of the quantity, reachability, and water use on the lunar surface is a significant robotic antecedent objective for the beginning phases of this plan.

- ✓ **Moon's resources can be used temporarily to fuel the spacecraft from the lunar surface to the Earth**, and they **can be utilized for journey to other stations** also. But actually, the Moon's surface is nearer to low Earth orbit than the Earth's surface. Fueling the spacecraft using lunar derived propellants will be great. Using Moon's derived propellants can be chiefly helpful for **interplanetary missions parting from an Earth-Moon liberation point or an extremely elliptical Earth orbit**. Using Moon acquired propellants must be a vast knowledge to decrease the cargo and manned Earth launch mass to Mars and other celestial bodies.

SOCIO-ECONOMIC BENEFITS OF LUNAR EXPLORATION

- The Moon depicts a possible resource for profitable exploration and use.
- There are many tendencies to use Earth's Moon for tourism, entertainment, or education.
- Aside that the Moon is of natural science value that makes it to be a possible observational platform. The lunar surface gives many other advantages to a stepping stone approach beyond the planet Earth.
- There is a wealth of precious raw materials in space, which is an effectively rare raw material with unlimited supply as the strain on the natural resources continues to increase on the Earth, asteroid mining is one of these (Jayachandran et al., 2018). There are many tendencies to take Moon's resources to be used on the Earth; e.g. to use energy generated on the Moon.
- Utilization of **the resources present on the moon which will allow missions deeper into the outer space** is one of the major reasons that revolves **around the human activity at the lunar surface** in relation to the long-term investigations program. Lunar based research therefore makes future human deep space missions feasible.
- The moon is a potentially lucrative source of helium 3 (useful for certain **magnetic resonance imaging (MRI)** and as a **possible fuel for nuclear power plants**); and a potential source of other rare earth elements such as **tantalium** and **europium** that are in **high demand for electronics use, solar panels and any other advanced gadgetry**.

APPROACH TO SOME RISKS ON LUNAR EXPLORATION FOR DEEP SPACE HUMAN MISSIONS

- The major focus is to keep humans alive, happy and healthy on the celestial bodies. Identifying, designing and predicting technology requirements for **Environmental Control and Life Support System (ECLSS)** for colonizing the Moon is the first task need to be performed to keep them alive (Jayachandran and Oluwafemi, 2021). This will involve **recycling**.
- The possibility of the lunar station for deep space manned missions should be evaluated in contradiction of the **great differences in climatological and geological histories, atmospheric factors, thermal, dust, gravity, and other environmental factors** amongst the Earth, Moon, and Mars.
- The Moon does have an atmosphere, although it is very thin to breathe and has composites that are bad for the lungs**. Oxygen, nitrogen, carbon and hydrogen are the main elements essential for life support that are found in the Moon's regolith**. Therefore, there is going to be a **need of a substantial energy to get these elements by refining lunar rock**.

CONCLUSION

- ✓ **Lunar based research therefore makes future human deep space missions feasible**. Since the Moon is seen to be a good planetary body as an exploration proving ground, off-world habitat development and Earth's neighbor.
- ✓ Need for global cooperation.
- ✓ Next step - recommendations for the mission planning.
- ✓ Socio-economic benefits are involved.

THANKS FOR LISTENING

For Collaborations/ Comments/ Suggestions/ Questions

Funmilola Oluwafemi
oluwafemifunmilola@gmail.com

REFERENCES

- Jayachandran, A.V.T., Oluwafemi, F.A., Israel, Y., Akinwale, A.T., 2018. Space mining corporation: the pseudo-economic and technology model. In: Proceedings of the 69th International Astronautical Congress (IAC), Bremen, Germany, 1–5 October, 2018. IAC-18,A3,IP,48,x43397.
- Oluwafemi, F.A., De La Torre, A., Afolayan, E.M., Olalekan-Ajayi, B.M., Dhital, B., Mora-Almanza, J.G., Potrivitu, G., Creech, J., Rivolta, A., 2018. Space food and nutrition in a long-term manned mission. Adv. Astronaut. Sci. Technol. 1 (1). https://doi.org/10.1007/s42423-018-0016-2. https://rdcu.be/bPumi.
- Oluwafemi Funmilola Adebisi and Jayachandran Thomas Aurthur Vimalachandran (2021). Plant Growth in Space: A Case Study of Sorghum Growth On Microgravity Simulator as a Theoretical Model. SSRN: https://ssrn.com/abstract=3829100 or http://dx.doi.org/10.2139/ssrn.3829100.