

## HOW DO WE DEVELOP AN ETHICAL FRAMEWORK FOR LUNAR RESOURCE UTILISATION? M. de Zwart, ARC Centre of Excellence in Plants for Space, Andy Thomas Centre for Space Resources, Adelaide University, melissa.dezwart@adelaide.edu.au.

**Introduction:** What are the legal and ethical principles that should guide future activities on the Moon, including resource utilisation? How might the presence of humans affect the formulation of in-situ resource utilization frameworks?

The Outer Space Treaty provides that ‘the exploration and use of outer space should be carried on for the benefit of all peoples’ and that ‘exploration and use of outer space...shall be the province of all [hu]mankind’ (Article I). Article II establishes the non-appropriation principle, forbidding states from claiming sovereignty over any area of outer space, including the lunar surface, and Article IX requires states to conduct their activities in outer space with ‘due regard’ for the corresponding interests of other states and so as to avoid the ‘harmful contamination’ of space.[1] Further the (non-binding) COSPAR Planetary Protection Policy mandates specific protections to preserve evidence of life and protection of science in planetary exploration and utilisation.[2]

However, the precise application of these laws and policies is not clear in the context of planned lunar activities. Neither has there been a precise calibration of the various interests and practices sought to be permitted and facilitated across these diverse instruments.

This paper will briefly consider what the extent to which environmental protection of the lunar surface may be addressed in the context of planned lunar settlements and in-situ resource extraction projects. It will conclude that the development of agreed ethical and legal guidelines which address environmental concerns are urgently needed to ensure both the ethical utilization of lunar resources and the peaceful and safe conduct of lunar activities.

**Potential lunar surface impact:** Virtually all physical activities on the Moon (and any other planetary body or asteroid) will impact the environment of that body. NASA has already identified the significant risk of plume surface interactions due to surface activities proposed for the Moon, noting that whilst ‘significant gaps in knowledge still exist’ activities on the surface are likely to generate profound and impactful environmental challenges. [3] Those challenges include the effect of lunar gravity, vacuum, solar weather and the terminator and how these may interact with human and robotic activity is still the subject of modelling rather than direct experience. [4]

With many lunar robotic and human missions planned for the next decade, there is therefore little direct evidence of how proposed human settlements, including landing and take-off zones and in-situ resource activities will impact the lunar environment. [5] In addition to the activities foreshadowed by Artemis and the International Lunar Research Station, the US, China and Russia have each announced plans to construct a nuclear reactor to provide a regular source of power for lunar activities.[6][7]

On Earth, these activities and their interaction with the surrounding environment may be managed pursuant to international and domestic laws, including environmental laws and plans. This may encompass both legal obligations and broader ethical principles, which may address preservation of unique areas, protection of heritage or significant sites and allocation of multiple use rights, including educational, research and cultural practices.

Beyond the implications relating to damage of the unique lunar environment itself, experience on Earth has demonstrated that environmental damage can pose long term threats to human safety, commercial opportunities, scientific discovery and create other unanticipated harms. As Kramer states, adverse environmental harms may be mitigated by environmental assessments and planning before undertaking activities, as is done on Earth. In fact, such planning may be even more important in space than on Earth, as the bioregenerative properties that exist on Earth, such as wind, water and natural biological growth, do not exist on the Moon. Any damage that occurs on the Moon may indeed be irreversible and therefore, more catastrophic than on Earth. [8]

There is however no overarching environmental management policy that applies to lunar activities. There have been proposals for preservation of the Apollo landing sites, even suggestions regarding the value of studying such sites for evidence of biological contamination and the possibility of survival of life on the harsh lunar surface.[9]

Current scientific evidence indicates that there are no living entities on the Moon. There are no plants, no rivers or seas and only small deposits of water ice in locations on the lunar poles. Therefore, it is contested as to whether the Moon could even be said to have an ‘environment’ which could be managed in a manner similar to Earth-based principles. Would environmental principles, which tend to be based

around the protection of human-centric values, still serve a purpose in the context of a 'lifeless' Moon?

**COSPAR Planetary Protection Policy:** These concepts of protection of science and the preservation of signs of life find practical expression and application in the Committee on Space Research (COSPAR) Planetary Protection Policy. The twin core goals of that Policy are to ensure that the integrity of scientific investigation of the possibility of extraterrestrial life is not compromised by the introduction of terrestrial biological material in that environment and to protect Earth from the introduction of alien contaminants brought back from returning space missions.[10] The Policy is regularly updated on the basis of current scientific knowledge and in light of planned missions.

Recent updates for the Moon include introducing new categories to protect the Permanently Shadowed Regions of the Moon, requiring such missions to meet a higher standard of record keeping with respect to their organic inventory. Implicit in this is the concept that whilst some parts of the Moon merit a higher standard of protection, there remains some 'right' to contaminate other regions.

Meltzer (and others) have noted that the COSPAR Planetary Protection Policy itself does not have an ethical underpinning. Rather it is a pragmatic response to the imperative to preserve evidence of life beyond Earth. [11] It is not explicitly concerned with broader concepts of environmental protection of mission destinations.

**A way forward?** The Artemis Accords prescribe the development and application of 'safety zones' to enable safe operation on the lunar surface. This concept was originally developed by the Hague International Space Resources Governance Working Group as a means 'necessary to assure safety and to avoid any harmful interference with that space resource activity'. [12] The concept of safety zones provides scope for varying purposes, duration and size, however, the concept does not currently address protection of sites for ethical, environmental, cultural or heritage values.

There has been very little consideration of the ethical and societal values, including whether the Moon itself should be regarded as a subject of environmental protection. If so, is that an environment worthy of protection in itself, or only as a subject of human utilisation? What are the environmental values to protect?

This paper suggests that the principles underpinning environmental protection on Earth create a basic starting point to address what areas the Moon should be protected or preserved for future purposes

and generations, demanding an urgent consideration of these issues.

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