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International Best Practice Principles

Impact Assessment of Extraterrestrial Activities

PURPOSE

These principles are intended to ensure that impacts on the extraterrestrial environment are appropriately considered in decisions relating to extraterrestrial activities and thus render them more sustainable. They are intended to help practitioners integrate consideration of the extraterrestrial environment into both project-level (e.g., Environmental Impact Assessment) and strategic-level (e.g., Strategic Environmental Assessment) Impact Assessments (IA).

BACKGROUND

The need for international best practice principles (IBPP) for Impact Assessment of Extraterrestrial Activities was identified by the IAIA Emerging Technology Section (now the Artificial Intelligence and Emerging Technology Section) which set out a process for their development involving the appointment of a Project Team. A draft of the IBPP was developed and refined by the Project Team through a series of virtual meetings. The draft was presented and discussed in a world café workshop at the IAIA24 conference in Dublin. The draft was revised based on the participants' feedback provided both in the workshop and by correspondence afterwards.

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Introduction

Impact assessments (IAs) have become a standard practice for major human actions that may affect humans and Earth's terrestrial, aquatic, and air environments. However, we have failed to recognize that our extraterrestrial actions, i.e., actions affecting celestial bodies including the Moon, asteroids, and other planets and their moons, may affect those other bodies based on learning from IA of our actions here on Earth. We should expect, for example, that mining for water ice on Mars may have similar impacts to mining on Earth, yet there are currently few regulations or practices favoring the use of IAs for extraterrestrial activities. The 1967 United Nations Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (the Outer Space Treaty) limits the proliferation or testing of weapons of mass destruction in outer space, cautions states to avoid harmful contamination of space and celestial bodies, and sets guidelines for forward biological contamination (transmission of Earth organisms to other celestial bodies) but is silent on other potentially adverse impacts. No enforcement provisions are provided.

Until recently, extraterrestrial impacts have not been a significant concern because of the small number of mostly scientific investigations on the Moon, Mars, and elsewhere in outer space over the past 50 years and their minimal impact on affected environments. That is rapidly changing. National space programs (National Aeronautics and Space Administration in the US, European Space Agency, China National Space Administration, Indian Space Research Organization, and others) have active plans for placing humans on the Moon and undertaking actions to support lengthy stays that require construction of infrastructure. Some are planning expeditions to Mars. Commercial private sector space enterprises such as the Space Explorations Technologies Corporation (SpaceX), Blue Origin, and others are planning on accessing the resources of the Moon, Mars, and asteroids. Their actions will, by design, affect those environments.

International best practice principles (IBPP) are required for IA of extraterrestrial activities if we hope to sustain continued use of those areas in an efficient manner, preserve options for future generations, protect human health and well-being, and respect humanity's beliefs and diversities.

Part 1: Definitions

Extraterrestrial environment: For the purposes of this document, the extraterrestrial environment includes all areas of the universe beyond the altitude of Earth's geosynchronous satellites (in excess of 35,786 kilometers above Earth's surface)[1]. For near-term practical purposes this would include our Moon, asteroids, and other planets and moons in our solar system as well as the space between celestial bodies (i.e., the vacuum), but would exclude all artificial Earth satellites. As with Earth's environments, the extraterrestrial environment would include, but not necessarily be limited to, all solid matter (e.g., regolith and ices, including subsurface matter), liquids (e.g., water and methane), gases and atmospheres, landscape features (e.g., mountains and valleys), geologic processes (e.g., volcanism and glaciation), sites of cultural interest (e.g., the 1969 Apollo 11 Moon landing site), potential alien life and their environments, and humans and their constructed environments and other material assets. Should human occupation increase in duration and numbers, the scope of the extraterrestrial environment may evolve to include human social factors.

Extraterrestrial activities: All human activities within the extraterrestrial environment and all human activities on Earth that may significantly affect those environments.

Part 2: Aims of the IBPP

It is recognized that the impacts of human actions are no longer confined to Earth but extend to extraterrestrial environments as well. Human actions there have increased in frequency and significance over the past decade and are expected to continue to increase dramatically over coming decades. Just as demonstrated on Earth, IA can assist in identifying adverse impacts during the planning process so they can be better avoided or mitigated; sustain natural resources; document the location, type, and duration of actions; help safeguard human health and wellbeing; identify key cultural and heritage sites; and provide other benefits.

The IBPP for Extraterrestrial IA are designed primarily for reference and use by those professionally involved in IA of extraterrestrial activities, but are also relevant to those involved in wider space policy and regulation. They will help raise awareness among decision makers and stakeholders and address concerns about impacts to the extraterrestrial environment in the planning and analysis of exploration and development. The systematic application of IA alerts decision makers to risks and consequences, and alerts them to the actions required to protect the extraterrestrial environment and to steps needed to ensure the long-term success of exploration and development activities. To date, where IA has been conducted for space projects and programs, it has usually only considered impacts to Earth's environment. Impacts on the extraterrestrial environment have either been ignored or covered only in a limited way. The aim of this document is therefore to clarify on behalf of IAIA, as the premier organization in the field, that:

- Extraterrestrial projects, plans, programs, and policies should be subject to IA of a similar standard to those currently afforded Earth-based activities.
- Impacts to the extraterrestrial environment should be adequately considered as part of this process.

The IBPP for Extraterrestrial IA have been developed to assist with filling the gap in this important area of practice.

Part 3: Principles

Two tiers of IA principles are included in this document: Overarching and Operating.

"Overarching Principles" are high-level principles aimed at establishing the importance and value of the extraterrestrial environment and the need to implement standards of assessment similar to those afforded Earth's environment. Although high level, the Overarching Principles have been selected to relate directly to IA. Therefore, they do not include the need for a global legal, regulatory and enforcement framework to cover extraterrestrial activities, as this goes significantly beyond the remit of IA practitioners.

The "Operating Principles" are aimed at establishing the mechanisms to assist with delivering the Overarching Principles given the specific circumstances and challenges associated with extraterrestrial IA. The Operating Principles are designed to cover those aspects of IA that require the greatest level of development or adaptation to be applied successfully in the extraterrestrial environment. Therefore, they do not repeat more general IA best practice principles, many of which will also apply to extraterrestrial IA. Other publications in the IAIA IBPP series should be consulted for information on those.

Overarching Principles

OVERARCHING PRINCIPLE 1: The environments of celestial bodies have the same intrinsic value as Earth's environment and should be subject to a similar level of protection. Even where celestial bodies are not occupied by humans, their environments should still be afforded similar protection to Earth's. The requirements of such protection will differ depending on the nature of the celestial body; therefore the level of protection should be effective but proportionate. Extraterrestrial IA should consider this and where the required protection has not been established in law, IA practitioners should use professional judgement to advise what protection is required.

OVERARCHING PRINCIPLE 2: Extraterrestrial IA should be undertaken for any policy, plan, program, or project that has the potential to cause significant impacts to the extraterrestrial environment, even if there is no legal or regulatory requirement to do so. IA practitioners should be professionally bound to advise those developing or promoting such policies, plans, programs or projects of the moral and ethical requirement to undertake extraterrestrial IA.

[1] Lower altitudes above Earth have been excluded from the definition because the impacts of lower and geosynchronous orbit satellites are almost entirely restricted to those orbits and Earthward. Also, space debris and issues regarding radio frequencies and light reflection are already significant concerns that are broadly recognized and, to some extent, regulated.

OVERARCHING PRINCIPLE 3: Activities within the extraterrestrial environment should be sustainable. Extraterrestrial IA should take account of and support relevant sustainable development definitions and objectives covering extraterrestrial activities, such as:

- "The long-term sustainability of outer space activities is defined as the ability to maintain the conduct of space activities indefinitely into the future in a manner that realizes the objectives of equitable access to the benefits of the exploration and use of outer space for peaceful purposes, in order to meet the needs of the present generations while preserving the outer space environment for future generations" as defined by the UN Committee on the Peaceful Uses of Outer Space (UNOOSA, 2021).
- "Ensuring that all humanity can continue to use outer space for peaceful purposes and socioeconomic benefit now and in the long term" as defined by the Secure World Foundation and adopted by the Earth Space Sustainability Initiative (ESSI, 2023).

OVERARCHING PRINCIPLE 4: Follow a precautionary approach. Considering the current novelty of extraterrestrial activities, and our general lack of experience in assessing their potential impacts and the paucity of information on impacts, a precautionary approach should be applied. The consequences of human activities for the extraterrestrial environment are likely to be unclear and there may not be sufficient information to exclude the possibility of unacceptable or irreversible impacts, or impacts that cannot be mitigated.

Operating Principles

OPERATING PRINCIPLE 1: The IA process should be interdisciplinary and transdisciplinary. This is to ensure that appropriate techniques are applied and expertise in relevant disciplines is consulted. In addition, as far as practicable and proportionate, IA should accommodate Indigenous knowledge systems and Indigenous perspectives.

OPERATING PRINCIPLE 2: Extraterrestrial activities should undergo thorough IA screening and scoping to ensure that IA is carried out where potentially significant impacts may arise and that appropriate topics are addressed. This is particularly important in the extraterrestrial environment where many of the topic areas are novel and may be untested. Knowledge will be gained with each subsequent IA that will assist in making future scoping and assessment processes more accurate and efficient.

OPERATING PRINCIPLE 3: IA should not hinder responsible use of extraterrestrial resources, including in-situ resource utilization of the Moon and other celestial bodies, where any adverse impacts, including cumulative impacts, are determined to be negligible or within acceptable limits or can be mitigated. Many components of the extraterrestrial environment are scarce natural resources that can be depleted or degraded, much like natural resources on Earth. IA should support the understanding and efficient, equitable, ethical, and sustainable management of these resources.

OPERATING PRINCIPLE 4: IA should be participatory and transparent. Consultation and approval methods need to be developed, as it is in the interest of all humankind to safeguard the extraterrestrial environment (as directed by Article 1 of the Outer Space Treaty (1967) that extraterrestrial areas are "the province of all mankind"). Boundaries for public consultation should be established reflecting this, while remaining pragmatic and proportionate. The process should provide appropriate opportunities to inform and involve the interested and affected parties, including the public, and their inputs and concerns should be addressed explicitly in the documentation and decision making[2].

References

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Glossary

Term	Definition/Explanation
Celestial body	A naturally occurring astronomical body such as an asteroid, moon, planet or star.
Extraterrestrial	Areas beyond the Earth's artificial satellite operational altitudes. Here, defined as areas greater in distance from the Earth than 35,786 kilometers (22,236 miles) and generally starting with the Moon and including all planets other than Earth, their moons, and asteroids, as well as the space between celestial bodies (i.e., the vacuum).
Geosynchronous satellite	A satellite in an orbit that allows it to maintain a fixed position in relation to a location on Earth.
Regolith	The blanket of material over solid bedrock, including material such as broken rock fragments and dust.
Space	Space or Outer Space is here considered to include the region of the universe beyond the atmosphere of the Earth, as defined by the Kármán line at 100 km above sea level, including the celestial bodies (therefore not only including the area of vacuum).

[2] Consultation with appropriate bodies such as the International Science Council's Committee on Space Research (COSPAR) should be undertaken, even in the absence of environmental agencies with clear regulatory powers for the extraterrestrial environment. Similar procedures to those used on Earth in international waters and the Antarctic may provide relevant consultation models.

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