

Necessity or Indulgence? Evaluating Space Exploration along a Necessity Spectrum

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Abstract. Public discussions of space exploration generally reduce to a single question. Is it necessary or a luxury to use public funds for it? This paper believes that the question is ill-posed; space exploration is not a single activity but a collection of activities with different moral connotations. Based on need theory, Aristotle's idea of the natural desire for knowledge, and Hume's analysis of luxury, a necessity spectrum has been established in this paper to classify each category of space activity according to the degree of harm and irreversibility resulting from its loss, the uniqueness of its benefits, and its opportunity cost. Based on the documented programmes, the framework indicates that Earth observation is an infrastructural necessity; planetary defence is a survival requirement; foundational space science meets an epistemic demand; deep-space crewed missions and space tourism, however, remain indulgences at present, and this status is not permanent. The paper then addresses the strongest objection to the framework, which is distributive justice, and argues that the objection is only successful against undifferentiated defences of space spending, as some space expenditure already functions as humanitarian assistance rather than as a diversion from it. Therefore, the policy will be differentiated investment, protecting indispensable infrastructure and survival capabilities, sustaining fundamental science at a reasonable rate, and continuously requiring discretionary projects to demonstrate their value over alternative investments.

Keywords: space exploration ethics, necessity spectrum, planetary defence, distributive justice, space policy

1. Introduction

On May 18, 2026, a near-Earth asteroid named 2026 JH2, about 14-30 metres in diameter, passed approximately 90,000 kilometres from Earth (about a quarter of the distance to the Moon), and had been discovered by the Mount Lemmon Survey only a few days prior. Astronomers ruled out the risk of an impact [1]. It was still near enough to revive a familiar question. How important is planetary protection, and how necessary is space exploration?

The answers to the public discussion are generally undifferentiated. Critics believe there are serious problems in the world today, and therefore, money spent on space is being wasted. Advocates answer with inspiration, spin-off technologies and destiny. Both sides think that space

exploration is an all-or-nothing problem, either in or out. However, space exploration is not a single item, and it cannot be classified wholly as either necessity or indulgence.

This paper proposes a more precise standard, a necessity spectrum along which each type of project is evaluated based on what its loss would cost, how unique its benefit is, and what it displaces in pursuit of that benefit. Under this standard, Earth observation is an infrastructural necessity; planetary defence is a matter of survival; foundational science is an epistemic requirement; deep-space crewed missions and space tourism are currently closer to indulgence, and this status is contingent rather than fixed. Given the above reasons, continuous investment in Earth observation and planetary defence is deemed essential civilisational infrastructure. Investment in transformative but non-essential exploration deserves support too, but only in a carefully controlled amount, regularly revised, and never at the expense of the world's most vulnerable people.

The rest of this paper is as follows. Section 2 presents theoretical studies of need and luxury, as well as research on the ethics of space expenditure. Section 3 introduces the necessity spectrum. Section 4 applies it to the four classes of space activities. Section 5 is the objection of distributive justice. Section 6 presents the deficiencies and subsequent plans for work.

2. Literature review

2.1. Theories of need and the concept of luxury

To divide between necessity and indulgence reasonably, one must first define what constitutes a need. Doyal and Gough offer the most systematic modern treatment, believing that good health and freedom of choice are things all people need to take part in society, and though the specific ways of achieving this vary among cultures, they are universally required [2]. At the bottom of this division is the separation of essential and universal needs on one side, and historically specific satisfiers on the other. The same structure can be used to distinguish between survival necessity, that is, physical security and the infrastructure for daily life, and what may be called epistemic necessity, the pursuit of fundamental knowledge about the universe.

The epistemic category has a classical start. Aristotle begins *Metaphysics* by observing that all people naturally want to know, and he considers the pleasure derived from learning to be evidence that curiosity is an innate trait of humanity rather than a product of culture [3]. On this view, the pursuit of fundamental knowledge is not a decoration added to life once serious business is finished. It is an expression of the will to know.

Hume provides the contrasting concept. Luxury is defined as "great refinement in the gratification of the senses" in his essay on refinement in the arts [4]. Two features of his analysis matter here. Luxury is not inherently negative, and its moral standing depends on the circumstances. It is vicious to pursue it at the expense of other duties or virtues, or when its cost is borne by those least able to afford it. Rather than a general condemnation, it is the conditional structure that the necessity spectrum takes from Hume.

2.2. The ethics of space expenditure

Philosophical studies on space expenditure have generally defended or criticised the enterprise as a whole. Schwartz believes that supporting space exploration can be seen as a moral duty rather than a choice between space exploration and humanitarian work; in fact, some forms of space activities aim to improve the lives of the people on Earth and ensure their future well-being [5]. Later, he held that the strongest support for space exploration came from the new knowledge gained in space.

Green surveys the field on a case-by-case basis, covering orbital debris and asteroid threats, commercial space flight and settlement, and shows that the ethical problems vary significantly depending on the activity under examination. Flexner's classic defence of useless knowledge holds that curiosity-driven research without a foreseeable application, such as the work of Maxwell and Hertz on electromagnetic waves, has repeatedly served as the foundation for later practical technology [6]. A recent large-scale survey of the public in several countries shows that the top public priority is given to space activities with an immediate positive impact on Earth, and among these, monitoring climate change and asteroid threats ranks first [7].

The above literature has failed to provide a general evaluation norm for this area. Wholesale defences invite wholesale objections, and case-by-case surveys fail to rank the cases relative to one another. A necessity spectrum will address the problem mentioned above.

3. The necessity spectrum

Necessity, in this context, refers to something that would cause serious harm to the world if it were not available. Three grades can be identified. Infrastructure necessity refers to systems that are required for routine decision-making and daily life; thus, the loss of such a system would disrupt normal life even in the absence of a single disaster. Survival necessity relates to the ability to face a foreseeable disaster in society at large. Epistemic necessity is the pursuit of basic knowledge, and according to Aristotle, it is regarded as an essential quality of people rather than an optional enhancement [3]. Indulgence, according to Hume, is refined gratification whose loss would seriously harm no one, and it becomes objectionable only when it is bought at the expense of duties owed to others [4].

Three questions determine an activity's position in the spectrum. The first asks how serious and how easily reversible the loss would be if the activity stopped. The second is whether the activity offers a benefit that nothing else can provide. The third is to determine what the activity replaces, and thus the opportunity cost at that time. The classification that results is explicitly time-indexed. As technology, cost and circumstances change, an activity may move toward necessity; therefore, the spectrum should be interpreted as an ongoing test rather than a fixed verdict. Each kind of project is evaluated according to how much of a loss would be incurred; glamour or controversy does not matter.

4. Applying the spectrum

4.1. Earth observation as infrastructural necessity

Earth observation satellites provide an obvious case for necessity. They provide the basis for climate model construction and disaster early warning systems, forecast crop-yield changes, and help with water-resource management under modern environmental management. The centrality of these datasets is reflected in the work that NASA is now undertaking to integrate its Earth science data services, including eleven distributed archives and near-real-time hazard information systems, into a single unified Earthdata platform, with an expected completion by the end of 2026. The same transition shows a vulnerability. The two main Earth-observing satellites of NASA, Terra and Aqua, will cease operation in late 2026 or early 2027 [8]. If these functions are not replaced in time, decisions such as agricultural planning and disaster relief will be made based on no data. Earth-observing satellites are not optional extras. They are public infrastructure.

4.2. Planetary defence as survival necessity

Planetary defence is now an absolute necessity for survival, as a large-scale asteroid impact would be devastating to humanity. The principal technology has moved from proposal to demonstration. In 2022, NASA's Double Asteroid Redirection Test mission struck the asteroid Dimorphos and reduced its orbital period by about 32 minutes; thus, it showed that kinetic deflection works [9]. The European Space Agency's follow-up mission Hera will arrive at the Didymos system in November 2026 to carry out a detailed post-impact observation of the deflected asteroid [10]. China has announced plans for a kinetic-impact deflection demonstration of its own, and a launch is scheduled for 2027; an impact on the asteroid 2016 WP8 is expected in 2029. Planetary defence is now a joint international effort rather than the work of any single organisation. Member states of the European Space Agency have committed 955 million euros to the agency's Space Safety Programme for the period 2026-2028, and the programme includes planetary defence [11].

The probability of a major strike each year is very small. However, the expected cost, in terms of lives and the continuity of civilisation, is high enough that space-based deflection functions as insurance. An insurance policy is worth the premium when the disaster it covers, however unlikely, would be economically devastating otherwise. A strike that would halt agriculture in an entire hemisphere is precisely such a disaster; it could not be solved by money.

4.3. Foundational science as epistemic necessity

The third kind of need is to learn some fundamental knowledge that can only be obtained from space-based facilities. The James Webb Space Telescope is an instance. Observation of the exoplanet WASP-39b found sodium, water vapour, carbon dioxide and carbon monoxide at a high level of significance in a single transmission spectrum, and this was unprecedentedly sensitive to the chemistry of distant atmospheres [12]. It has also found young star-forming galaxies about 400-600 million years after the Big Bang and measured substantial reservoirs of neutral hydrogen gas in them [13]. None of this knowledge has any foreseeable applications in daily life, and that is precisely the point. Epistemic necessity does not wait for utility to provide the reason; electromagnetism also did not wait for utility before being essential a century later. Aristotle's observation stands. People are naturally curious about knowledge and enjoy learning for pleasure, even when it is not immediately beneficial [3]. To cease such an inquiry would be to lose something very close to a characteristic trait of humanity.

4.4. Deep-space missions and space tourism as provisional indulgence

Deep-space crewed missions and space tourism currently appear to be luxuries because neither offers a benefit that is both unique and urgently required. Based on the survey results, the public's focus is on activities that immediately benefit the Earth, such as climate monitoring and tracking hazardous asteroids, rather than prestigious exploration [7]. Popularity alone is not the right test, though. A better question is what an activity has that nothing else can offer. Crewed Mars exploration currently provides no essential service. It is about geopolitics and scientific aspiration, and the competing national programmes consider a crewed landing a mark of technological and political prowess, much as the twentieth-century space race did. However, standing is not the same as necessity; therefore, a programme may be politically desirable without being indispensable to the lives and needs of ordinary people.

Space tourism intensifies the problem. GRU Space, an American company, has announced reservations for a commercial lunar hotel by 2032; with deposits of up to one million dollars [14], stays are expected to cost over ten million dollars, and the initial capacity will be only four people. Ventures of this type do not contribute to infrastructure, survival or foundational knowledge that would justify the cost, especially when that cost could be used to alleviate extreme poverty. Thus, both activities are open to strong objection under Hume's standard.

This norm should not be used as though commodification always rules out an activity. History offers a lesson here. Electromagnetism, quantum mechanics and evolutionary biology were all once regarded as wasteful curiosities, but now they have become necessary foundations; Flexner pointed out this very situation in the case of seemingly useless experiments that enabled wireless communication [6]. A feature of these historical changes is that none of them occurred at the expense of the poor. Nineteenth-century electromagnetism was the amusement of well-funded gentleman scientists. Early quantum theory was an abstract academic problem and did not divert resources from public welfare. Neither field competed with bread, medicine or shelter for funds. Both were underwritten by the surplus of wealthy patrons and universities, and the money would not have been used to help the poor. This is the reason why the historical comparison is fair and not convenient. Deep-space exploration and space tourism may follow the same path in principle, and with international cooperation and commercial innovation, planetary resource exploitation or off-world bases may eventually become real necessities. That possibility does not exempt them from scrutiny now. It means only that their status as indulgences is temporary rather than permanent, and that the real problem is not the label attached to an activity but its ratio of cost to urgent benefit at that time.

5. The distributive justice objection

The most serious objection to this framework comes from distributive justice. As shown by the World Bank, about 831 million people are living in extreme poverty, with less than \$3 a day of income, and many lack access to clean water or basic medical services [15]. Given the above content, is it worth spending several billion US dollars on space exploration? If the main drivers of spending are national prestige or private discretionary consumption, then it is not. Such spending is a pleasure purchased by failing in the duty to the less fortunate.

The objection is upheld only if space spending is treated as a single category, but the necessity spectrum shows that it is not. Schwartz believes that support for space exploration can be considered a moral responsibility rather than just one of many choices in altruism; in fact, some kinds of space activities directly serve human welfare [5]. Lower-cost projects in Earth observation are typical examples. NASA has collaborated with the humanitarian organization Mercy Corps to map groundwater resources in drought-prone areas of Niger and provided this data to local authorities [16]. The European Space Agency has worked with the World Bank to provide development assistance for building a national-scale flood and landslide risk map of the Dominican Republic, thus laying the groundwork for an early-warning system. The recipients of these tools are not rich countries. They are the vulnerable groups that need an early warning and resource assessment system, and thus some space spending is already humanitarian aid rather than a diversion from it.

Proportion matters as well. NASA's annual budget of about \$24.4 billion is roughly one-third of one percent of the US federal budget. Global military expenditure was approximately 2.887 trillion US dollars in 2025, about 100 times the budget of NASA [17]. The value of planetary defence and Earth observation cannot be expressed in terms of funds alone; for example, an undetected asteroid impact could cause damage of several trillion dollars and an irreparable loss of life. According to

Hume's rule, programmes that reduce systemic risk and extend the foundation of knowledge are easier to justify as public investment than many other large-scale expenditures that receive little attention.

6. Conclusion

This paper has not held out space exploration as either a need or a want. It has put forward the necessity spectrum as a more precise standard, and, rather than assigning a single label to the entire field, considers urgency, the seriousness of the potential loss, and opportunity cost. On that standard, Earth observation provides the information support for life in the modern era. Planetary defence addresses the survival of civilisation. The foundational science is required by human nature for epistemic reasons. Deep-space crewed exploration and space tourism are still "civilizational extras" at present; while captivating in curiosity and symbolism, they still owe the world an account of their opportunity cost.

2026 JH2 will not be the last asteroid to pass near Earth, and the next one may not be avoided. That is the quiet logic for treating planetary defence as a necessity rather than a hedge, and it is also why the ventures at the other end of the spectrum cannot simply borrow that urgency. Space exploration earns its place activity by activity, not as a single cause. Some activities civilisation cannot afford to lose. Others have not yet earned their costs against standing humanitarian claims. Hume's test still holds. Does the given expenditure cost something that is due to the vulnerable? Asked of every line item, the answer will not always be the same, and the division made will not always be pleasant. Earth observation and planetary defence are their own reasons. Deep-space exploration and lunar tourism will have to keep making their case for a long time.

The following are some defects of this approach. The necessity spectrum is a qualitative system, and no efforts have been made to operationalise its three criteria quantitatively. Most of the cases reviewed come from the United States and Europe's programmes, so it has not been applied to other countries. As the position in the spectrum changes over time, the divisions proposed here are subject to revision with new technologies and circumstances. Future work can formalise the criteria for the spectrum, expand the case scope beyond the agencies considered here, and study how institutions will implement the regular re-evaluation of discretionary space expenditure required by the framework.

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