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Why space exploitation may provide sustainable development: Climate ethics and the human future as a multi-planetary species

Konrad Szocik [a,b,*,1], Michael J. Reiss [c,2]

[a] Interdisciplinary Center for Bioethics, Institution for Social and Policy Studies, Yale University, Prospect St. 238, New Haven 06511, USA
[b] Department of Social Sciences, University of Information Technology and Management in Rzeszow, Sucharskiego 2 St., 35-225 Rzeszow, Poland
[c] University College London, Institute of Education, London, UK

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ABSTRACT

Depletion of resources on Earth, super-exploitation and climate change challenge human survival on Earth. As far as humans are a single-planetary species, our further survival seems to be seriously threatened by these on-going pressures. In this paper, we discuss ethical issues arising from the possibility of space exploitation and space colonisation as remedies for a forthcoming climate catastrophe. We argue that it would be unwise to presume that in the time span required humans will change their behaviours and/or develop new technologies so that irreversible, harmful climate change on Earth is averted. Space exploration and exploitation are considered as a natural continuation of the human attempt to explore and exploit. We conclude that space colonisation may provide a path to the sustainable development of humanity and that it would be remiss of humans not to explore this possibility seriously.

1. Introduction

Anthropogenic global climate change is increasingly recognised by the scientific community as beyond reasonable doubt (IPCC, 2021). The scientific focus is no longer on whether humans are responsible for substantial changes to our climate but on how we might slow down or even reverse future changes and ameliorate their effects. The ethics of climate change involves such philosophically and politically important concepts as justice, equality, sustainability, duties and obligations towards the living and non-living world, as well as towards future generations. As Fergus Green and Brandstedt (2020, pp. 12237) rightly argue, we need an engaged climate ethics that will make a tangible difference to what would otherwise happen. As such, climate ethics should also incorporate population ethics. Indeed, we propose that both climate ethics and population ethics be extended to include the ethics of space exploration. Environmental ethics or, in our case, environmental space ethics is also a point of reference. However, in this paper we do not refer to the issues classically discussed within environmental space ethics, which principally focus on duties in the case of an encounter with extra-terrestrial life, or the moral status of the uninhabited cosmos.

All philosophical attempts at discussing current and future challenges caused by climate change (which we use as a shorthand for 'anthropogenic global climate change') are worthy of attention. However, the position we take in this paper is that decision makers as

* Corresponding author at: Interdisciplinary Center for Bioethics, Institution for Social and Policy Studies, Yale University, Prospect St. 238, New Haven 06511, USA.
E-mail addresses: konrad.szocik@yale.edu (K. Szocik), m.reiss@ucl.ac.uk (M.J. Reiss).
[1] ORCID: 0000–0002-7262–3915
[2] ORCID: 0000–0003-1207–4229.

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well as many scientists are erring by failing to consider seriously one way out of our present climate crisis. The error lies in the fact that, excepting science fiction, humans usually see ourselves as a single-planetary species. Our argument is that while humans, currently, live on only one planet, this conceptual constraint introduces not only philosophical but also social, political and scientific limits which may lead to hazardous effects in the long-run.

In this paper, we defend the notion that humans should adopt a multi-planetary way of thinking about themselves, and apply it to political philosophy and environmental ethics as far as these and other disciplines are worried about climate change and the future of humanity (by which we mean the human species/race). We fully acknowledge that at present neither the technology nor the political will exist to establish off-Earth colonies but we argue that space colonisation may offer a remedy for the problem of climate change. We presume that the effects of climate change are likely to be severe for much of humanity at the global scale in the near future. We take it as read that we do not need here to rehearse the specifics of the deleterious effects that humans are having on the Earth both with regards to climate change (global warming, ocean acidification, sea level rises, increasing numbers of extreme weather events, etc.) and more generally (loss of biodiversity, soil degradation, damage to water supplies, increasing risks from infectious diseases, etc.). Of course, nothing in our arguments means that humans should not try urgently to ameliorate the adverse consequences of climate change here on Earth. Rather, our argument is that limited planetary capacity, combined with overpopulation and exploitation, are barriers that can be at least partially addressed by adopting an interplanetary perspective. Such a perspective would allow for the channelling of scientific and technological efforts toward the exploitation and exploration of space, while giving hope to many investors for the possibility of exploiting new areas beyond Earth. This would mean that space should already be recognised as a natural area for the widest possible human activity, while at the same time setting the direction for development.

1.1. Capitalism and the desire to exploit 1 – the vicious circle of humanity and human progress

Let us start from the idea that humans have modified and exploited natural environments for as long as we have existed. There are many civilizations and societies that have collapsed due to overexploitation of resources (Diamond, 2005). Others have survived the onset of resource scarcity, showing the complexity of the problem, which is affected by many factors. Some of these are independent of humans, such as climate change before the Anthropocene, while others depend on political and economic systems (Jenkins, 2021). Currently, substantial numbers of people in the richest and most developed societies, not to mention their political leaders, are apparently greatly disinclined to renounce the luxury, comfort and diverse facilities they increasingly expect from everyday life. But humans who are used to such benefits are only one factor in the problem. Another factor is powerful corporations that gain benefits from the exploitation of natural resources. When Lee McIntyre studies the genesis of the phenomenon of post-truth, he identifies its roots in a movement of science denial situated in the long-running policy of tobacco companies to obfuscate about the links between cigarette consumption and adverse health consequences (McIntyre, 2018). As another more recent example, he discusses the case of the denial of scientific facts about climate change, inspired and financed by oil and other energy companies. So far as the exploitation of natural resources is profitable, at least some big corporations will try their best to exploit all available resources. The source of the problem is therefore structural and largely related to the unequal and unjust share of power held by capitalist corporations. Although this is a characteristic of only a small portion of humanity, the exploitation of a huge portion of the planet by colonial states and corporations, and now global capitalism, mean that this model originally confined only to the West has come to dominate almost the entire world, leading to exploitation that to date is proving very difficult to arrest. A third dimension to the problem is partially associated with the above-mentioned human reliance on technology. Even if one imagines an optimistic scenario where humans decide to reduce substantially their demands on the environment and successfully put this decision into effect, this may not happen (the two of us will be delighted if we are proved wrong) globally to a sufficient extent for three reasons. First, humans too often do not behave in an altruistic or just way. Such a way of deciphering so-called human nature (let's use the term as a convenient technical shortcut) has even led some philosophers to the idea of biomedical moral enhancement, controversial though this is (Wiseman, 2014). For instance, Ingmar Persson and Julian Savulescu begin from the premise that two main challenges today and in the near future for the future of humankind are weapons of mass destruction and climate change. But because humans are not adapted psychologically and morally to current environmental conditions, Persson and Savulescu recommend biomedical modification of human morality (Persson & Savulescu, 2014). They assume that without such artificial and invasive intervention in human psychology, we should not expect any radical change in human behaviours. While we do not, of course, dispute the presence of altruistic tendencies and behaviours among people, such altruism should not be overemphasised, let alone used to create policy scenarios and action plans that assume altruism as the default driver of action. Then there is the historical fact that it is hard to change drastically but voluntarily human habits that are deeply and essentially rooted in a technological civilisation. As such, we need to take seriously the possibility that the inhabitants of the richest and most privileged societies (but also all those who consume the most energy from fossil fuels) will fail to reduce substantially the rates at which they consume resources that are in limited supply. Indeed, it seems more likely that resource depletion will continue as will the harmful effects, including climate change, on our environment. Thirdly, even if one assumes optimistically that at least the wealthiest countries will be able to reduce things like energy consumption rate substantially and/or (a more realistic assumption) move to renewable energy sources (as is already happening), we cannot ignore other countries inhabited by billions of people.

This is an issue of sustainable development, by which we mean changes that meet the needs of those alive at time t without compromising the needs of those alive at times subsequent to t. For example, the current average annual energy consumption rate per capita in Iceland (5777 watts per person, the highest national figure in the world) is over five thousand times higher than in Chad (1 watt per person), almost two thousand times higher than in Somalia (3 watts per person) and over seven hundred times higher than in Uganda (8 watts per person) (The World Factbook, 2021). Energy consumption is highest in the most advanced technologically countries, and while renewables are making great strides (indeed, to be fair to Iceland, it leads the world in this regard), not all energy

demand is likely to be covered by renewable energy sources (as is the case even in Iceland); furthermore, unless careful life cycle analyses are performed (that take into account such things as the use of concrete for wind farms and the costs of decommissioning), the carbon demands of renewables are typically underestimated by politicians and the public alike.

The story of global inequalities in energy consumption is repeated when we consider global variation in annual carbon dioxide emissions per capita. Such emissions in Luxembourg (41.8 tonnes per person) are over four thousand times higher than in Rwanda (0.01), over one hundred times higher than in Senegal (0.33), and more than ten times higher than in Romania (3.75), itself, along with Luxembourg, a member of the European Union (EU Science Hub, 2018). Such data indicate the great difficulties of tackling climate change. Furthermore, it is difficult to see how presently less advantaged countries can do anything but increase their contribution to climate change in the years to come (cf. Larrabee, 2019). Despite countless attempts in recent decades at reversing the situation, it remains the case that climate change is continuing – the world is getting warmer, sea levels are rising, extreme weather events are becoming more frequent and the oceans are acidifying. While the two of us hope that these so far inexorable trends will be reversed, we have been so hoping for decades (one of us is an ecologist and has been teaching and writing about climate change since the 1980 s). One possibility is that geoengineering projects to counteract climate change, such as the one currently supported by Bill Gates to reflect sunlight away from the Earth's atmosphere (Cohen, 2021), prove to be successful. Such projects, however, not only still require some technical obstacles to be overcome, but also demand a clear stance with regards to environmental ethics (this includes whether such global projects should be funded by private investors).

For the above reasons, it seems wise not to assume that climate change will soon reverse. Indeed, it seems wiser to plan for the possibility that power structures based on the global capitalism will not change their dynamics of unsustainable exploitation, given limited resources. A further reason for this assumption is the possibility that humanity today is close to the critical point known as super-exploitation. Super-exploitation entails a situation where existing exploitation of resources means that it is no longer possible to access (sufficient) new resources (Elvis & Milligan, 2019). We acknowledge that there has been a long history in the environmental movement of 'crying wolf' – of claiming that we are in imminent danger of running out of oil or whatever. Nevertheless, for all the enthusiasm about the increasing recycling of metals, rare-earth elements and so forth, the two of us would not want to bank humanity's future on such re-use and recycling proving sufficient. In any event, our main concern here is not the total depletion of certain resources but the climate consequences of their exploitation and usage. Frankly, we cannot dismiss as apocalyptic the fear that an increasing proportion of the Earth's surface will be incapable of sustaining agriculture or (in the absence of air conditioning – itself a growing contributor to global warming) even simply the permanent presence of humans. Of course, constructing shelters on Earth, such as under the surface, whether for agriculture or residency, is one form of adaptation to climate change. Besides, at least in the near term, space will be available for exploration, exploitation, and perhaps settlement only to a small number of people, probably the most privileged. However, this does not change the fact that at the same time as carrying out intensive adaptation activities to climate change on Earth, the serious implementation of a large-scale programme of space exploration and exploitation will provide new added value for humanity in terms of novel technologies and access to raw materials.

1.2. Capitalism and the desire to exploit 2 – space exploration and exploitation as a unique opportunity

It seems deeply unwise to assume that humans will soon rein in their tendency to consume beyond the resources of planet Earth. It is worth bearing in mind that the evolutionary mismatch between moral psychology and modern moral ecologies makes humans rarely good at adapting to emergency situations that are different from those we evolved to face (such as avoiding predators and sheltering from adverse weather). Despite the developing global climate crisis, many people around the world still do not accept the reality of climate change (Fagan & Huang, 2019), a reality that is relatively easy to deny, given the variableness of weather and the long period of time over which climate changes. Many people do not do anything to change their lifestyle towards a more carbon-neutral model. While in this paper we do not discuss in any detail the psychological and cognitive issues which lie behind our consumer habits, there is no doubt that they play a substantial role.

Psychological and cognitive constraints are not the only constraints that are relevant. Some constraints may be included in the very nature of capitalism. Jason Hickel (2018) argues that there can be no compromise between capitalism and the environment. Economic growth requires the exploitation of resources and therefore results in unavoidable environmental pollution. This is the point where the future of our planet, the idea of sustainable development and the survival of the human species intersect. Let us now presume that capitalistic economic growth is intrinsically connected with excessive (i.e., unsustainable) exploitation of resources and environmental pollution. We then face a scenario of existential catastrophe as long as humans inhabit only the one planet, at least until the number of people on that planet sufficiently reduces to enable a sustainable balance between exploitation of resources and our planet's capacity to produce these resources. There are at least two ways in which our presumption might be proven invalid. First, if capitalism ceased to be the dominant economic system; secondly, if capitalism no longer required ever increasing amounts of limited material resources, instead moving towards a sustainable use of such resources. We would naturally be delighted if either of these two ways resulted. Nevertheless, at the time of writing we cannot be confident that this will be the case. Nor does the science of evolutionary biology does not leave much space for hope. Natural selection works through overpopulation and limited resources. Both factors work today against the future of the human species on Earth. Malthusian law is a related concept which is applicable here. These evolutionary dynamics work against human survival (or, to be less apocalyptic, human survival in a world that has not been ruined) due to our exploitative attitude and (present) planetary boundaries. Such an exploitative approach is not necessarily inherently wrong, in so far as an exploitative species possesses access to virtually unlimited resources. However, this is no longer the case for humanity living on only our present planet. Of course, while humans, in common with other species, are subject to the workings of natural selection, we are able, unlike other species, consciously to make decisions that go against our narrow evolutionary interests – witness the widespread use

of contraception, for instance, and helping behaviours that cannot be reduced to the kin selection and reciprocal altruism found in other species. Nevertheless, two issues which work here against the continued survival and flourishing of the human species are limited resources and global climate change. There are other existential threats – such as from nuclear weapons, pandemics and possibly Artificial Intelligence. While they are not the focus of this paper, we note that the solution we advocate for addressing climate change may also help ameliorate these other threats to humanity (Szocik et al., 2020).

But things will change if and when humans become an interplanetary species. Of course, asteroid mining is not going to help anytime soon with climate change on this planet. Nevertheless, colonisation of other astronomical objects, including Mars and beyond (though within our Solar System for the foreseeable future),[3] with asteroid mining, can help address the problems we are discussing, for all that extra-terrestrial resources are both finite and expensive to obtain. Pollution on Earth might even, eventually, reduce (if there are fewer people here, partly as a result of more of us moving elsewhere), and new resources will be exploited beyond Earth. While some ethicists have argued that humans do not have a right to exploit space, such arguments are unlikely to be widely held to be convincing if the survival of the human species is at stake; here, the phrase 'survival of the human species' might be taken literally or to refer to a situation where the most we can hope for is a return to some sort of subsistence economy capable of sustaining, in some misery, only a tiny proportion of the number of people currently alive. We take it for granted that the survival of the human species will be seen by most people (certainly, those with political and economic power) as possessing a value that transcends philosophical discussion. Of course, valuing humans because of their capacities, or simply because of a speciesist self-interest, does not exclude respect for non-human beings, and other ethical positions in environmental ethics such as sentientism, biocentrism or ecocentrism exist. However, if human survival as a species is at stake, we assume that there are strong reasons for deriving the deontic conclusion that the survival of the human species as a species is a moral obligation, and that one of the means – perhaps even the only means, depending on the circumstances – may be the exploration and exploitation of space even at the risk of contaminating previously pristine space environments.

If the scenario of large-scale space colonisation is realised in some point in the future, it may be more possible to realise the goal of sustainable development on Earth. The two of us do not favour rampant exploitation of either terrestrial or extra-terrestrial environments. Exploitation of resources should be based on rational, defensible principles and on a respect for all living organisms and for non-living entities too, as far as possible. However, taking into account all relevant factors, including the capacity for human pleasure and suffering, overpopulation of the Earth, the dynamics of human economy, human nature and the fact that the existence of life in our Solar System, especially sentient life, has not yet been found, there is a strong argument that the colonisation of space becomes a moral duty. Ethical objections to such colonisation are weakened precisely because the astronomical objects that we might colonise are not inhabited – at least, not inhabited by sentient beings, let alone beings who are aware of their interests. Consequently, space colonisation aimed at resource exploitation is substantially different from the long and awful history of rapacious colonisation realised in the past by the western countries on Earth. The new space colonisation will not lead to the subjugation of indigenous people, to their enslavement, to their genocide, although the emergence of new forms of oppression against some of those exploring or inhabiting space cannot be ruled out.

Humanity should develop and apply certain criteria to reduce the risk of environmental destruction in space, but these should not prevent space exploitation. One historical precedent may be the Antarctic Treaty System (British Antarctic Survey, 2021). This originally came into force in 1959 with the signatures of twelve nations. Over time, it has been modified and currently has 52 signatories. These signatories meet annually and discuss such issues as scientific cooperation and measures to protect the environment; decisions are arrived at by consensus. Some authors argue that future space exploitation should be restricted by legal principles. The main purpose of such limits would be to enhance the likelihood of the future survival of humanity against the above-mentioned risk of super-exploitation. One proposal is the so-called one-eighth principle (Elvis & Milligan, 2019). This idea states that people should exploit not more than one-eighth of the total available resources that are detected in the Solar System. Due to exponential growth, when people cross that line, they will be well on the path to exhausting the resources, assuming that colonisation beyond the Solar System is not possible.

One could say that people will always exploit all available resources if they do not meet any constraints ('The tragedy of the commons'). In a pessimistic scenario, humanity in the future, even if humans become a multi-planetary species, may take paths that lead to self-destruction and to the super-exploitation of all resources available for us in the Solar System – or even beyond. In an optimistic scenario, humanity will evolve culturally with sufficient efficacy to self-limit our consumption rates and, of course, some individuals do indeed already self-limit their consumption rates. Such cultural evolution would, at least to some extent, be dependent on available technologies which would (hopefully) enable such things as a substantial reduction in the consumption of energy, major improvements in re-use and recycling and concomitant reductions in environmental pollution. In that sense, extra-terrestrial colonisation is buying us time.

However, and somewhat ironically, the issue of environmental pollution and the harm that it causes humans is greatly reduced in space as long as humans are dependent on life support systems to enable us to live in what would otherwise be uninhabitable areas. That fact that Mars is already, from the perspective of life on Earth, utterly unsuitable for living and, in that sense, exceptionally polluted – about 95% of the Mars atmosphere is carbon dioxide and radiation levels are far in excess of what we find on Earth, and the same point holds for all other astronomical objects of which we know – can be seen as an *advantage* for human plans for the exploitation

[3] When we talk about space colonisation, we do not necessarily mean a mass migration of large numbers of people – that seems unlikely in the near future. On the other hand, it cannot be ruled out that at some point in the future, significant numbers of people will be able to leave the Earth and live elsewhere.

of space resources. The main challenge caused by current climate change is not the depletion of such resources as oil, coal and gas. The challenge lies in the fact that the quality of life on much of our planet is getting worse and risks getting in the not-too-distant future to a critical point where the survival of a large part of humanity may become all but impossible. A shortage of access to fresh water, soil degradation or occasional days with daytime maximum temperatures and/or high humidity that make it impossible for temperature regulation to occur will make human life unviable over increasing areas of the Earth. Yet, these factors which will challenge human survival on Earth are a day-to-day reality elsewhere. As such, space colonisation will, rather paradoxically, be largely free from the environmental constraints that are today the main source of future global existential risk for human survival. At the same time, it needs to be acknowledged that the vulnerabilities of the various life support systems should not be underestimated. It would be substantially easier to ameliorate the conditions in the most inhospitable of Earth environments than to terraform parts of Mars.

A final point of emphasis in this section. Aside from our own Moon, the body in the Solar System that is most likely to serve as a base for colonisation in the not-too-distant future is Mars. It is possible, of course, that we might get to the point where the Earth, Moon and Mars between them are running out of resources. The hope would be that by then we would have made sufficient progress in space technologies to enable us to colonise new destinations in space; hopefully, it might additionally be the case that we would have learnt some of the lessons of history and developed sufficient cultural awareness and norms to temper the expression of our over-exploitative nature.

2. Political and ethical issues in space exploitation and colonisation

The very idea of space exploitation and colonisation discussed in terms of a way of addressing a grossly deteriorating environment on Earth raises political and ethical issues. If ever realised in the future, such exploitation and colonisation will make the human species a multi-planetary species. That in itself will have a host of political and ethical consequences.

2.1. Political challenges

The starting point for the idea discussed in this paper is an assumption that there is an increasing mismatch between the human population on the Earth and humanity's demands on the Earth's environment. It will simply not be possible for things to continue as they are. One can envisage a number of possible scenarios (not necessarily mutually exclusive): (a) technologies advance so that humanity does manage to live sustainably and in large numbers on the Earth without colonising space and without our quality of life falling; (b) in the manner described by many science fiction authors, humanity does manage to continue to live on the Earth but in much smaller numbers and in circumstances of widespread environmental degradation and where human quality of life is low; (c) humanity manages to colonise other bodies in our Solar System. Our analysis is based on our worry that scenario (b) is at least as likely as scenario (a) and that therefore we owe it to ourselves to begin planning now to engineer scenario (c).

Of course, space colonisation would give rise to political considerations. Decisions about how to design space colonies and who should be sent into space are decisions about how to design a future social and political order in space. There are a number of possible political systems that could be envisaged, ranging from a relatively exclusivist technocracy, though some sort of dictatorship or totalitarian system, to a form of democracy (Wójtowicz & Szocik, 2021). We can also mention a factor which will shape the dynamics of future space colonies, namely the fate of the Earth and whether it remains a habitable planet. If it does, some space settlers may at some point want to come back to Earth, even if that has adverse consequences for other space settlers. If the Earth does not remain a habitable planet, then the survival of humanity relies on at least one extra-terrestrial colony being self-sustaining.

2.2. Ethical challenges

This paper has examined ethical arguments about extra-terrestrial colonisation as a possible solution to the problem of human degradation of the Earth's environment. Ethical challenges that arise in connection with space exploitation and colonisation closely relate to the political issues. As we noted above, we do not consider concerns about damage to space environment to be sufficient to prohibit human space exploitation and colonisation. In the unlikely event that we do find life elsewhere in the Solar System we suspect that a combination of caution and conservation would be appropriate. It is difficult to see any fundamentally new ethical issues arising, though analogy with pristine environments like Antarctica is not the same as actual equivalence in terms of ethical or other challenges. There is the unresolved question of whether any differences in the degree of ethical problematics between Earth and the cosmos are qualitative or quantitative. One particular ethical issue is the discovery of extra-terrestrial life and its origins in comparison to the origins of life on Earth. Bioethical issues are another (Szocik, 2021). In the latter case, it is also possible to find some parallels between the ethics of space missions and military ethics if only in relation to the specific issues of limitations to autonomy, which, although widely recognised as one of the most important ethical principles, is limited in its functioning in such a hierarchical structure as the military (Szocik & Reiss, 2022).

Elsewhere, we have suggested that the extreme environments that humans will encounter in space (high radiation loads, very different gravities, etc) mean that the arguments in favour of radical human enhancement, e.g., through germ-line gene editing, may be considered much stronger (Norman & Reiss, 2020; Szocik, 2020; Szocik, 2021). Indeed, we suggest that such enhancement may become a legal requirement for long-distance space travellers.

Another ethical issue is connected to population biology. In small and closed groups (a rule of thumb is where there are fewer than a couple of thousand reproductive individuals), the effects of mutations can be more important, as the phenomenon of genetic drift means that, for stochastic reasons, disadvantageous mutations can become much more abundant than natural selection would permit

in larger populations. The sort of liberal reproductive freedoms that many of us have come largely to take for granted – that it is our choice whether or not to reproduce, with whom to reproduce and whether or not to continue with a pregnancy – may come under pressure. This is an issue which deserves further treatment as it touches on human freedom, liberties and basic human rights. A further, not unrelated, ethical issue is to do with privacy. We have already suggested that radical human enhancement may become a legal requirement. This would need to be policed. More generally, it may be questioned whether space colonists would have the rights to privacy of genetic information that is standard nowadays.

2.3. Financial returns and the concept of deep altruism

Finally, we note, with respect to an issue that combines political, ethical and economic considerations, that special attention should be paid to ways of financing space colonisation. Before such a project will provide a return on investment, and for a very long time, invested costs would be very substantially higher than any likely benefits. Indeed, it is very possible that investors would not reap any financial benefits partly because of the timescale of such a project (discounted cash flow analysis) and partly because such a long-term project is aimed at the well-being of future generations rather than the remuneration of present funders. This is a situation that is unattractive from a capitalistic point of view. In response, Jacob Haqq-Misra offers the concept of 'deep altruism', which expresses a concern for the multi-generational effort required to launch a space colony successfully (Haqq-Misra, 2019). Alternative possibilities to financing space colonisation include arguments other than those based on economic returns.

Data availability

No data was used for the research described in the article.

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