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New Space Tourism Sustainability as an Evolving Concept

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Review

New Space Tourism Sustainability as an Evolving Concept

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Abstract The recent emergence of the tourism sector in the New Space industry, that provides commercial alternatives to publicly funded "Old Space" operations, fits within other societal trends enhanced by technological developments. There are several possible forms of space tourism and, within each, a growing number of competing space tourism ventures will emerge over time. However, whilst the New Space tourism industry is to provide a tourist with new travel experiences, international climate reports urge for more sustainable operations in all global industries. Therefore, climate change preventing solutions must be sought to decrease any unnecessary impacts caused by this new adventure sector of tourism from the beginning. As there are different variables to consider in the formation of future New Space tourism operations and strategies, this paper also illustrates a new framework of "Societal ethics in space tourism", involving concepts attached to New Space tourism sustainability; environmental actions, global space regulations, cyberspace tourism, and Generation Z values.

Keywords New Space; space tourism; sustainable development; space ethics; climate change

1. Introduction

Space tourism can be viewed as a logical development of the ever-increasing distances tourist travel and the future exploration of the space environment as a natural extension of humankind's desire to explore [1]. In 2021, Virgin Galactic, Blue Origin, and SpaceX, all owned by globally influential and wealthy visionaries, gained pioneering status of being the world's first fully operating commercial space tourism companies. As previous trends in adventure travel have already blurred the boundaries between adventurous activities and tourism [2], the emergence of the New Space industry tourism sector means a postmodern tourist is no longer expected to be trained as an astronaut to be able to observe planetary movements. The Western perspective on travel has also become more dominant than ever, hence the impacts caused by future tourism activities are often calculated from that perspective [3].

Traditionally, the concept of sustainability in the tourism industry has been present in making an inventory of sustainable tourism initiatives, in the impact of transport in tourism, in sustainable tourism and transport policies, and in prevailing questions in the field of sustainable tourism development [4]. Sustainable tourism is defined by World Tourism Organization as "tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment, and host communities ([5], p. 11). Sustainability in tourism involves economic, environmental, and sociocultural aspects, which due to the nature of tourism, could be complex and even work against sustainability: for example, when the number of tourists exceeds the carrying capacity of environmentally fragile areas [6].

After the release of the recent Intergovernmental Panel Climate Change (IPCC) reports [7–9], which highlight the Earth's environmental emergency, there has also been a rise in equality issues and ethics within the tourism industry involving debates on the most appropriate way of holidaying. There have been travel destination boycotts and social media shaming of tourists involved in highly polarised activities, such as animal trophy hunting. Similarly, according to Marsh [10], there are ethical dilemmas involved in space tourism, especially as there remain grey areas separating the minimum legal requirements and ethical responsibilities of the actors involved [3]. According to Gren and Huijbens ([11], p. 15), ethics has traditionally foregrounded human subjectivity, but existence can no longer be reduced to "humans among themselves", as for the first time in its history humanity is confronted with the task of "having to carry the Earth on its own shoulders". Hence ethical responsibility appears to have become fundamental in Earth's approach to global social sustainability. Therefore, besides the sustainable adaptation to

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environmental climate change, any future touristic actions will require ethical-based competences from the stakeholders involved.

Due to global climate change related concerns around increased emission levels, there is obvious apprehension about environmental issues arising at the start of the commercial space tourism industry, as there is similarly also a lack of global space legislation related to New Space tourism activities. Space tourism activities will involve a variety of risks that can be termed environmental and detrimental effects may impact the Earth (i.e., the building of the spaceports), atmosphere (i.e., the emissions from the space tourism vehicles), and space environment (i.e., future colony mining on the soil of the Moon or Mars). Hence the objective of this paper is to discuss the sustainability aspects, currently seen in the global tourism industry, in relation to future space tourism.

2. Conceptualisation of New Space Tourism

During the 1980s, the term "New Space" emerged, referring to commercial space markets with an intention to differentiate developing businesses in the space industry from the traditional business structures and norms established during the first space race [12]. After the turn of the millennium, rapid developments in technology accelerated predictions for the beginning of the commercial space tourism industry. During the 2010s, a global transition took place in regard to the space environment, as the New Space industry involving private spaceflight tourism companies emerged as an active player alongside existing governmental actors for space activities [6].

The characteristics of New Space include competition (due to technological improvements), the increase in private investment leading to reduced cost (hence increasing the profitability), and public demand for increasing data contributing to increased commercialisation [13]. New Space companies (including tourism) have business attributes and technology development activities associated with their business models such as flexible organisational structures, willingness to take risks, and a focus on new technology solutions [12].

Harrington ([14], p. 118) defines a space tourist as "someone who tours or travels into, to, or through space or a classified body for a pleasure and/or recreation". New adventures and unique experiences, such as seeing the Earth from space, drive the demand for space travel [6]. According to Reddy et al. ([15], p. 1101), "two aspects in particular have to be taken into consideration when explaining space tourism motivation. First, the pioneering aspect, which motivated the first private space explorers to push the barrier and experience something that only astronauts have done before and, secondly, the space flight experience which attracts many people with all the excitement and uniqueness." Crouch et al. ([16], p. 451) claim that there is a significant portion of the public, in general, and of high-income or high-net-worth individuals in particular, who are favourably disposed towards engaging in some form of commercial space tourism flight activity.

There are various types of space tourism, the typology involving: terrestrial space tourism such as Earth-based activities and cyberspace tourism; atmospheric and low Earth orbit tourism; astrotourism, referring to experiences beyond Earth's orbit; and lunar and Mars experiences [17,18]. Terrestrial space tourism is already well-established and includes Earth-based simulations and entertainment experiences such as visits to space observatories and museums, star gazing with a telescope, and seeing the Northern Lights in person [18]. Cyberspace tourism includes experiences such as virtual gaming environments and virtual reality space travel, and according to Ceuterick & Johnson [19], interactive media and contemporary video games even represent "a major site at which future visions of space tourism can be displayed and directly interacted with, allowing players to experiment with modalities of extraplanetary transit".

The recently emerged sub-orbital space tourism, operated by Blue Origin and Virgin Galactic, is the first stage of so-called "common man" space environment exploration, as it does not require passengers to partake in lengthy astronaut training beforehand. Some intensive flight training is required, however, covering weightlessness as well as safety training. However, similar to current aviation industry developments, there are different types of space touristic vehicles under construction by various private companies. For example, North American Space Perspective and European Zero 2 Infinity are both currently testing high-altitude space balloons for future touristic purposes. Their launch system would have a significantly lower impact on the environment compared to fuel-based rocket options [6,20].

In astrotourism, the International Space Station (ISS) in low Earth orbit has so far been the ultimate destination for adventurous space tourists, offering a floating apartment complex with several activity areas and observation posts to view Earth and outer space. In the future, space

infrastructure innovations may enable more comprehensive research to inform the design of experiments on longer-term physiological changes due to space flight; indeed, these discoveries may help to colonise the Moon and Mars [21].

3. The Megatrend of Environmental Sustainability

Futures forecasting is needed to understand the future concepts of commercial space tourism commonly still related to science fiction. Early signals of emerging trends can be used to recognize patterns [22,23]. When turning into global megatrends, these can be harnessed in shaping the new business era and become part of its formative process [24]. Many of the current global megatrends relate to climate change, identifying, for example, that "ecological reconstruction is a matter of urgency" [25]. Spector et al. [26] even proposed that the traditional scales of sustainability in local, regional, national, and global areas need to be expanded beyond the biosphere as the Earth should no longer be considered the "sole realm" of human influence and responsibility.

The environmental concerns around global greenhouse gas emission pathways, raised in the recent years IPCC climate change reports, have also enhanced extant knowledge towards a personal carbon footprint and influenced the need for alternative and sustainable ways of travel in the future [3,27]. Currently, the International Transport Association (IATA) states that approximately 2% of global CO_2 emissions come from the aviation industry, hence from the environmental point of view future travel beyond the biosphere will also have an extra environmental impact on the Earth's climate.

According to Miraux et al. [28], the environmental footprint by future space tourists is to become higher compared, for example, to other forms of tourism transportation when quantifying the impact of planned commercial space flights from 2022 to 2050. It has been estimated that total carbon dioxide emissions from one launch per passenger are about 100 times those of a typical long-haul flight [29]. Also, the development rocket based point-to-point travel on Earth and future space colony establishments may increase the stress on the orbital environment as well as the global New Space sector on the Earth's resources and ecosystems [28].

Accordingly, the launching stage of a rocket pollutes by creating emissions, dust and noise in the local area, and increases the amounts of atmospheric aerosols and small sub-micron particulates, which create changes in atmospheric thermal structure, and also contribute to "global dimming", which will additionally threaten space touristic activities such as terrestrial stargazing [30,31].

Therefore, Ryan et al. [29] conclude that space tourism (and commercial experiments on satellites) needs to be developed in a more sustainable manner in the future as the soot released by space tourism can actually have a bigger impact on the climate than the soot from aviation. This is because rocket launches release pollutants and greenhouse gases into several atmospheric layers and persist for much longer (years) in the middle and upper atmosphere, compared with when equivalent pollutants are released at or near the Earth's surface [29].

4. Ethics and New Space Tourism Sustainability

The rapid development of interest and investment in New Space tourism has created its own trajectory that introduces a new dimension to conventional notions of sustainability, questioning how this can be applied to the space industry, space-related tourism, and the tourism industry as a whole [31]. Therefore, a theoretical literature review, mainly from the fields of tourism research and futures studies, was accomplished and the data was interpreted by thematic analysis, to illustrate some concepts attached to New Space tourism sustainability. Figure 1, named "Societal ethics in space tourism", visualises the concept of ethics as the core element. The framework also includes sub-concepts of cyberspace tourism, environmental actions, global space regulations, and Generation Z values.

Figure 1. "Societal ethics in space tourism" framework.

5. Environmental Actions

According to Miraux et al. ([28], p. 330), "as the world is becoming more aware of the urgent need to reduce the environmental footprint of human activities, while at the same time becoming increasingly reliant on space-based assets for various essential services (e.g., communications, climate and environmental monitoring, emergency response and disaster relief), ensuring a sustainable future for space activities is critical". Despite its relatively short existence, the New Space tourism industry has already presented some operational level sustainability not previously seen in the traditional governmental led "Old Space" industry. For example, in 2018, SpaceX achieved the world's first repeat flight of an orbital class rocket, presenting a historic milestone for full rocket reusability. Webber [32] even claims that the key to understanding the whole field of the emerging space tourism industry is operational reusability, as the price elasticity of demand for the human payload is high, hence the need for reusable rockets.

As already seen in the aviation industry, there are voluntary environmental actions taken by airlines offering options for passenger travel carbon offsetting to mitigate the impact of air transport and to "neutralize" its atmospheric consequences. According to Broderick [33], such voluntary action has been targeted to ease passengers' ecological conscience by selecting an alternative option, such as a sustainable service or payment. More generally, such compensation schemes have been targeted at the prevention of environmental deterioration caused by climate change [34]. Even though the carbon offsetting can be viewed as a "free licence to pollute", it is a concrete action towards future environmental protection, and such action is increasingly being utilized in the global tourism industry. Feelings of awe in experiencing the Earth from space, such as those already described by astronauts, could eventually even create new schemes of environmental protection on Earth benefiting from money being donated either from the space tourism company or their passengers, replicating the current aviation industry practices.

Nevertheless, there are already some critical questions attached, such as how does flying with compensation compare from an environmental perspective to the option of not flying, and will new destinations such as "space" attract people who would not otherwise have flown, but because of the possibility to compensate in the form of beneficial donations choose to do so? A further question appears around whether pioneer "space jump" tourists would also be willing to support sustainable planning that furthers the space tourism product palette, such as travel to the Moon, or would they just be interested in compensating for their personal footprint on the space jump they take [6]? Furthermore, a deeper analysis could ascertain whether the development processes for New Space tourism infrastructure could be considered a waste of the Earth's resources (as such processes could have been targeted at preventing climate change). However, satellites that assist daily activities on Earth, enhanced by the technological progress in reusable innovations in

the New Space tourism industry, have already demonstrated their rapid response to global natural disasters with accurate data, supporting rescue operations and monitoring the impact of climate change more accurately.

6. Global Space Regulations

There are currently global discussions about which laws and regulations should apply to commercial space flight and space tourism, and which should be further developed to fit the future variety of space flights in any existing category, either within space activities and space law or within aviation and air law. Alongside the development of the New Space industry, there are also plans for private space mining, falling under another legal sector for example, air law is completely irrelevant to the ownership of space resources [35]. This raises questions such as how should New Space industry activities, including tourism, be globally regulated, especially in terms of sustainability, to harness private businesses and countries globally, and also, will there be a global scale political will and a private sector imperative to mitigate damage to the space environment (even to leave some potential space tourism space locations untouched) [36]?

It needs to be noted that whilst the development of outer space will have significant implications for Earth's inhabitants, only a small section of individuals, companies, and governments are currently involved in the development of the New Space industry [31]. The question of such inequality has already been noted in the United Nation's reports on climate change and poverty and have even forecasted that the world will soon face a "climate apartheid", in which the rich can escape the consequences of global warming by emigrating to space, for example, leaving the poor to suffer the impacts [37]. Carrington [38] claims that the impact of climate change enhances the suffering to humanity (according to many scientists), hence the importance of humanity's survival, potentially through space exploration.

The emergence of the New Space industry brought a completely new commercial sector to space operations. Space is no longer only entered by countries with space programs, but also by various private companies working as commercial contractors. Such space activities involve multinational businesses, which typically have tended to result in accelerated environmental destruction as the ideology in private space businesses revolves around the maximisation of economic profit [39]. Space tourism, in theory, represents an idealized experiment for future international and domestic policy implementation as it in one part determines whether private and public valuation of an environment can co-exist [40].

The opening of space for many activities such as space tourism has made it necessary to specify new types of regulatory frameworks that have not been covered by the Space Treaty [41]. The Outer Space Treaty [42] corresponds to maritime laws and constitutes the only legislation in existence for common space responsibilities. The Treaty includes the principles governing the activities in the exploration and use of outer space, including the Moon and other celestial bodies, to avoid harmful contamination of space. It provides the basic framework of international space law, but makes a limited reference to environmental issues; even though in the light of current debate on climate change, this should become one of the highest rankings on the agenda to agree on new legally binding global space legislation.

However, the existing global space legislation is not up to date to reflect on the usage of the space environment for commercial purposes. Currently, space is subject to a "first come first served Wild West" attitude as the only existing legislation for common space responsibilities is the Outer Space Treaty [42], which corresponds to maritime laws [39,43]. As global regulations for the New Space industry are limited, sustainable decision-making has so far been an ethical responsibility choice practised by private companies [44]. For example, increased New Space industry satellite constellations create a risk for space debris in the case of future collisions, which will further complicate and even endanger the safety of other commercial space activities such as space tourism [45]. Hence there are several ethical and legal questions around sustainability such as at what cost (to human society) should the private space sector be allowed to pursue its goals and what should the ethical responsibilities of private space entrepreneurs be both on Earth and in outer space [44]. Moreover, it has been noted that in situations involving collective responsibility, the polluter who pays the contribution appears to be particularly powerless, as it is not able to determine the entity that should bear the costs, nor ensure a just process by which compensation can be secured. Hence in the New Space industry, including tourism activities, it may be challenging to reach a consensus on the comprehensive application of the polluter-pays principle

in outer space and the ensuing channelling of all liability to the operators of environmentally harmful activities [39].

7. Cyberspace Tourism

According to Yeoman [46], consumer values in Western society have changed, with a decreasing emphasis on material possessions and an increasing concern for experiential issues. Cohen and Taylor [47] claim daydreaming and space tourism are attempts to escape, in which people participate non-physically or by actually jetting away from social monotony and from themselves. Utopias paint a picture of perfect worlds, and are thus seen as a form of pure escapism in an ideal world in which people feel happy and comfortable [46]. Travel is a luxury product of experience, however, commercial space tourism at the pioneering phase is to offer unique experiences only to affluent travellers, something that is difficult for the average person to replicate [48].

As one of the current megatrends is to embed technology into future activities [25], virtual space travel in a virtual Metaverse environment could become an alternative choice to experience space. After all, virtual reality technologies can change the way humans interact in the future and provide a practical solution for many without the necessary funds or the necessary physical or age standards to have an authentic experience [49]. The realism that virtual reality experiences provide lends itself well to virtual tourism experiences, and once the sensations and emotions of visiting somewhere in virtual reality become essentially indistinguishable from visiting it in real life, the distinction between the two will become less dichotomous and more a matter of variations [50]. Consequently, virtual tourism could eventually compete with real-world travel and alter tourism purchase patterns more broadly, with various effects on the tourism sector [51].

8. Generation Z Values

According to Spector and Higham [52], the social norms determining what kind of travelling is socially acceptable and even desirable also arise within space tourism development, concentrating on the implications for those who are excluded or otherwise left behind. Some of the future influences to impact global tourism industry concentrate on the travel motivations of "Generation Z", who are highly involved in digital solutions trends, such as social media platforms, and are generally invested in changing their lifestyles and environments [27]. Hence the increased number of young travelers capturing similar travel photos in the same destinations and posting these on the internet for others to see, to join the mass "status" travelers [6]. Such postmodern tourism styles can be described "as individuals who enjoy multiple experiences embracing different, sometimes contrasting, life values" ([53], p. 298), already visible, for example, in tourists looking for authentic cultural attractions, but also visiting artificial tourist destinations such as Disneyland.

With space as a "destination", a budget optimization for travel is not yet possible as space cannot be accessed without a specially designed space vehicle. Hence this may result in a new class division among Western society as younger generations, in particular, have become accustomed to equal accessibility [27]. Indeed, the division between different social groups will be extreme in the pioneering stage of space tourism. As the estimated ticket cost is $450,000 per "space jump" [54], it is obvious that only the wealthy are able to access space if they are not sponsored otherwise.

Therefore, the holistic concept of sustainability needs to be expanded to new dimensions of conventional notions of sustainability [31]. As the pioneering space tourists come from influential backgrounds (due to the cost of the ticket), they simultaneously become vulnerable to public criticism, if the public, including Generation Z, is to identify commercial space tourism only as another activity where "rich people pollute the Earth more". Therefore, a sub-orbital space jump experience shared on social media may in the worst-case scenario impact a space tourist's personal business partnerships if they also become related to "flight shame", which is an anti-flying label enhanced by Generation Z representative and environmental activist Greta Thunberg.

9. Conclusion

The concept and importance of sustainable development have been globally recognized for decades; however, the recent years IPCC reports currently emphasize very strong concerns for the Earth's environmental longevity. Due to the increased emission levels contributing to further

climate change, there is obvious apprehension about the environmental issues that arise at the beginning of a new tourism activity in the context of the New Space industry. There is also criticism about the lack of global New Space regulations, the ethical synthesis of influential private sector commerce and publicly funded infrastructure, especially relating to the concentration of power. A similar concern also relates to the backgrounds of the pioneering space tourists, who due to high ticket costs, come from privileged segments of society. This calls for questions regarding whether the understanding of an authentic space environment will be a new separating power of knowledge, and will it cause equality issues, especially among Generation Z, who have become accustomed to similar travel possibilities and practises. As there are different variables to consider in the formation of future New Space tourism operations and strategies, this paper illustrated a framework of "Societal ethics in space tourism" concepts attached to New Space tourism sustainability; environmental actions, global space regulations, cyberspace tourism and Generation Z values. As the New Space tourism industry is a private sector participator in the space environment besides the previously exclusive national and military usage, global regulations, as well as environmentally sustainable methods of action need to be resolved quickly or alternatively voluntarily pursued, particularly to ensure the most minimal future impact in regards to climate change.

Conflicts of Interest

The author has no conflict of interest to declare.

References

1. Williamson, M. (2003). Space ethics and protection of the space environment. *Space Policy*, *19*(1), 47–52. https://doi.org/10.1016/S0265-9646(02)00064-4
2. Beedie, P., & Hudson, S. (2003). Emergence of mountain-based adventure tourism. *Annals of Tourism Research*, *30*(3), 625–643. https://doi.org/10.1016/S0160-7383(03)00043-4
3. Toivonen, A. (2022). The emergence of New Space tourism: A grounded theory study of enhancing sustainability in space tourism from the view of Finland. *Acta electronica Universitatis Lapponiensis*. University of Lapland. https://urn.fi/URN:ISBN:978-952-337-311-2 (accessed 4 September 2022).
4. Verbeek, D., & Mommaas, H. (2008). Transitions to sustainable tourism mobility: The social practises approach. *Journal of Sustainable Tourism*, 16(6), 629–644. https://doi.org/10.1080/09669580802159669
5. UNWTO. (2005). *Making tourism more sustainable: A guide for policy makers*. United Nations Educational Programme.
6. Toivonen, A. (2020). *Sustainable space tourism – An introduction*. Channel View.
7. IPCC. (2018). *Summary for policymakers of IPCC Special Report on Global Warming of 1.5 Celsius approved by the governments*. https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approvedby-governments (accessed 2 January 2022).
8. IPCC. (2019). *The Intergovernmental Panel on Climate Change Report*. https://www.ipcc.ch (accessed 10 January 2022).
9. IPCC. (2022). *Climate change 2022: Impacts, adaptation and vulnerability*. https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii (accessed 21 April 2023).
10. Marsh, M. (2006). Ethical and medical dilemmas of space tourism. *Advances in Space Research*, *37*(9), 1823–1827. https://doi.org/10.1016/j.asr.2006.03.001
11. Gren, M., & Huijbens, E. H. (2014). Tourism and the Anthropocene. *Scandinavian Journal of Hospitality and Tourism*, *14*(1), 6–22. https://doi.org/10.1080/15022250.2014.886100
12. Hay, J., Guthrie, P., Mullins, C., Gresham, C., & Christensen, C. (14–17 September 2009). *Global space industry: Refining the definition of "New Space"*. AIAA Space 2009 Conference & Exposition, Pasadena, CA, USA. https://doi.org/10.2514/6.2009-6400
13. Ministry of Business, Innovation and Employment of New Zealand. (2021). *Space-related opportunities in New Zealand*. https://www.mbie.govt.nz/science-and-technology/space (accessed 4 September 2022).
14. Harrington, A. (2017). US State Spaceflight Liability and Immunity Acts in Context. In J. Wouters, P. De Man, & R. Hansen (Eds.), *Commercial Uses of Space and Space Tourism: Legal and Policy Aspects*. Edward Elgar.
15. Reddy, M. V., Nica, M., & Wilkes, K. (2012). Space Tourism: Research Recommendations for the Future of the Industry and Perspectives of Potential Participants. *Tourism Management*, *33*(5), 1093–1102. https://doi.org/10.1016/j.tourman.2011.11.026
16. Crouch, G. I., Devinney, T. M., Louviere, J. J., & Islam, T. (2009). Modelling Consumer Choice Behaviour in Space Tourism. *Tourism Management*, 30(3), 441–454. https://doi.org/10.1016/j.tourman.2008.07.003
17. Carter, C., Garrod, B., & Low, T. (2015). *The encyclopaedia of sustainable tourism*. CAB International.
18. Cater, C. (2019). History of space tourism. In E. Cohen & S. Spector (Eds.), *Space tourism: The elusive dream* (pp. 51–66). Emerald.
19. Ceuterick, M., & Johnson, M. R. (2019). Space tourism in contemporary cinema and video games. In E. Cohen & S. Spector (Eds.), *Space tourism: The elusive dream* (pp. 93–115). Emerald.
20. Zero 2 Infinity. (2023). *Simplifying access to space*. https://www.zero2infinity.space (accessed 21 April 2023).
21. Caplan, N., Winnard, A., & Lindsay, K. (22 June 2017). *Here is what space tourism could do for science and health research*. The Conversation.
22. Choo, C. W. (2007). Information life cycle of emerging issues. http://choo.fis.utoronto.ca/ncb/es/EsinfoLC.html (accessed 26 August 2022).
23. Hiltunen, E. (2007). *Where do future oriented people find weak signals?* FFRC Publications.
24. Naisbitt, J. (1982). *Ten new directions transforming our lives*. Warner Books.
25. Dufva, M. (2020). *Megatrends 2020*. Sitra. https://www.sitra.fi/julkaisut/megatrendit-2020 (accessed 3 May 2022).

26. Spector, S., Higham, J. E. S., & Doering, A. (2017). Beyond the biosphere: Tourism, outer space and sustainability. *Tourism Recreational Research*, 42(3), 237–282. https://doi.org/10.1080/02508281.2017.1286062
27. Ritalahti, J. (2021). Customer insights and sustainability and responsibility in leisure travel intermediation in Finland. In M. Lück & C. Liu (Eds.), *A kaleidoscope of tourism research: Insights from the International Competence Network of Tourism Research and Education (ICNT)* (pp. 253–270). Peter Lang.
28. Miraux, L., Ross-Wilson, A., & Dominquez-Calabuig, G. J. (2022). Environmental sustainability of future proposed space activities. *Acta Astronautica*, *200*, 329–346. https://doi.org/10.1016/j.actaastro.2022.07.034
29. Ryan, R. G., Marais, E. A., Balhatchet, C. J., & Eastham, S. D. (2022). Impact of rocket launch and space debris air pollutant emissions on stratospheric ozone and global climate. *Earth's Future*, *10*(6), e2021EF002612. https://doi.org/10.1029/2021EF002612
30. Ramanathan, V. (2007). Global dimming by air pollution and global warming by greenhouse gases: Global and regional perspectives. In C. D. O'Dowd & P. E. Wagner (Eds.), *Nucleation and atmospheric aerosols* (pp. 473–483). Springer.
31. Scott, M. (2022). A space tourism destination: environmental, geopolitical and tourism branding considerations for New Zealand as a "launch state". *Journal of Sustainable Tourism*, *30*(9), 2240–2253. https://doi.org/10.1080/09669582.2020.1817049
32. Webber, D. (2019). Current space tourism developments. In E. Cohen & S. Spector (Eds.), *Space tourism: The elusive dream* (pp. 163–175). Emerald.
33. Broderick, J. (2009). Voluntary carbon offsets: A contribution to sustainable tourism? In S. Gössling, C. M. Hall, & D. Weaver (Eds.), *Sustainable tourism futures: Perspectives on systems, restructuring and innovations* (pp. 169–199). Routledge.
34. Williams, V., Noland, R., Majumdar, A., Toumi, R., & Ochieng, W. (2007). Mitigation of climate impacts with innovative air transport management tools. In P. Peeters (Ed.), *Tourism and Climate Change Mitigation: Methods, Greenhouse Gas Reductions and Policies* (pp. 91–104). NHTV.
35. Von der Dunk, F. (2019). The regulation of space tourism. In E. Cohen & S. Spector (Eds.), *Space Tourism: The Elusive Dream* (pp. 177–199). Emerald.
36. Duval, D. T., & Hall, S. M. (2015). Sustainable space tourism. New destinations, new challenges. In C. M. Hall, S. Gössling, & D. Scott (Eds.), *The Routledge Handbook of Tourism and Sustainability* (pp. 450–459). Routledge.
37. Alston, P. (2019). *Climate change and poverty*. UN Human Rights Council. https://digitallibrary.un.org (accessed 2 December 2022).
38. Carrington, D. (2019). *Climate crisis: 11,000 scientists warn of 'untold suffering'*. The Guardian. https://www.theguardian.com/environment/2019/nov/05/climate-crisis-11000-scientists-warn-of-untold-suffering (accessed 8 August 2022).
39. Viikari, L. (2007). *The environmental element in space law. Assessing the present and charting the future*. Brill Nijhoff.
40. Webber, D. (2013). Space tourism: Its history, future and importance. *Acta Astronautica*, *92*(2), 138–143. https://doi.org/10.1016/j.actaastro.2012.04.038
41. Von der Dunk, F., & Tronchetti, F. (2015). *Handbook of space law. Research handbooks in international law*. Edward Elgar Publishing.
42. Outer Space Treaty, United Nations. (1967). *Treaty on Principles Governing the Activities of Space in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*. U.S. Department of State. https://2009-2017.state.gov/t/isn/5181.htm (accessed 22 April 2023).
43. Vereshchetin, V., Vasilevskaya, E., & Kamenetskaya, E. (1987). *Outer space. Politics and law*. Progress Publishers.
44. McFadden, M. (6 February 2018). *SpaceX and the ethics of space travel*. Prindle Post. https://www.prindlepost.org/2018/02/spacex-ethics-space-travel (accessed 14 November 2021).
45. Wall, M. (13 February 2019). *Tickets to Mars will eventually cost less than 500,000 dollars, Elon Musk says*. Space. https://www.space.com/elon-musk-spacex-mars-missionprice.html (accessed 1 December 2021).
46. Yeoman, I. (2008). *Tomorrow's tourist: Scenarios and trends*. Elsevier.
47. Cohen, S., & Taylor, L. (1992). *Escape attempts: The theory and practice of resistance to everyday life*. Routledge.
48. Wittig, M. C., Albers, M., & Sommerock, F. (2017). *Rethinking luxury: How to market exclusive products and services in an ever-changing environment.* Lid Publishing.
49. Damjanov, K., & Crouch, D. (2019). Virtual reality and space tourism. In E. Cohen & S. Spector (Eds.), *Space tourism: The elusive dream* (pp. 117–137). Emerald.
50. Perry Hobson, J. S., & Paul Williams, A. (1995). Virtual reality: A new horizon for the tourism industry. *Journal of Vacation Marketing*, *1*(2), 124–135. https://doi.org/10.1177/135676679500100202
51. Guttentag, D. (2021). Digital destinations and avatar tourists: A futuristic look at virtual reality tourism and its real-world impacts. In I. Yeoman, U. MacMahon-Beattie, & M. Sigala (Eds.), *Science fiction, disruption and tourism* (pp. 145–160). Channel View Publications.
52. Spector, S., & Higham, J. (2019). Space tourism, the Anthropocene and sustainability. In E. Cohen & S. Spector (Eds.), *Space tourism. The elusive dream* (pp. 245–262). Emerald.
53. D'Urso, P., Disegna, M., Massari, R., & Osti, L. (2016). Fuzzy segmentation of postmodern tourists. *Tourism Management*, *55*, 297–308. https://doi.org/10.1016/j.tourman.2016.03.018
54. Virgin Galactic. (2022). *Virgin Galactic spaceflight*. https://www.virgingalactic.com (accessed 15 July 2022).