Reading the Stars

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Executive Summary

Narrative evidence, often neglected, can inform future UK space policy and strategy. This report is designed for strategic decision makers, but will be of interest to a wide readership including researchers, technical experts, and practitioners. It identifies, synthesises, and presents narrative evidence on space drawn from a range of activities including expert assessment of policy issues, synthesis papers, a workshop, and narrative analyses, and is intended to be used as part of a plural, innovative and novel evidence (PINE) base to drive the development of better space policies and strategies. As with any synthesis, the value lies in the selection of issues that has emerged from the process, and the attention paid to evidence that may be known to some, but on the margins of current public reasoning. Incorporating these findings into today's policy and strategy typically requires determination although for each reader there is, we hope, a moment of easy surprise or of changed recognition.

Situated within complex geo-political, technological, environmental and human landscapes of policy and knowledge, much of the potential impact of the future uses of space on multiple forms of regional, national and local growth (beyond that on communications) is yet to come. Despite its growing importance, space policy is at present in many ways too niche to have been systematically explored in public debate or to have been studied through all the disciplinary lenses that might illuminate it. Where space policy is publicly discussed, it is often through narratives and perspectives that are locked-in for the wrong reasons from a policy perspective: primarily because space has historically been the site of imagination, exceptionalism, and charismatic narratives.

The report considers first the pathways and positioning that should inform policy. It presents evidence that:

- Those who speak about the UK's space policy need to find ways better to position its national successes, as well as allowing for the public resonance of its (honourable) failures.
- In linking history to the future, space practitioners could and should be clearer about the importance of networked sovereignty and that future national success is most likely to rely on collaboration between nation states and on private and public partnerships. Narrative models can go beyond the general, to enable surrogative reasoning about what these partnerships might look like and be especially helpful in exploring the implications of multi-national but not nearly global collaborations, and those between entities other than existing nation states and businesses.
- Anticipations of future arrangements of autonomy and power should include narrative and other forms of evidence about potential Earth-colony (including Earth-crew) relationships. There is scope here to develop new narrative models of past terrestrial structures and anticipate a wider range of future space-based ones.
- As the range of potential uses and users of space increases, it will be important to consider shifts in actual and desirable uses, particularly where those move away from presumptions of law and politics that are essentially based on unexamined notions of empire, colony and extraction and which could lead to mistakes or the creation of fragile policies. Afrofuturist narrative models of space exploration could provide useful alternative framing, while Native American perspectives include accounts of the relationships between Earth and space that in turn might help find new ways to link approaches to Earth land use, such as for launch sites, with space travel.
- One of the many actual challenges to making decisions today that will enable good public-private partnerships in the future is that of managing multiple assumed timescales. Both sectors can move fast and slow, and both have

roles in setting pace and timescales to achieve multiple benefits in different phases. Individual narrative models explore those choices.

- Linked to the findings on future Earth-colony relationships is the need to consider the inevitable emergence of new collective identities and their implications for exploration, ownership and governance. Distance from home, even a small distance, changes collective behaviours.
- Finally in this section, evidence from studies of architecture, and the roles of architecture in narratives, point up the need for something like a professional standard of care for architects of physical environments in space, and the need to consider both how newly created spaces change people, and how people change to adapt to those spaces.

The second part of the report examines the roles of wider public participation in space policy and the intersections of space and climate in policy and debate.

- Space debris already hinders activities in space, but practitioners argue that it is hard to get traction for new approaches. Wider public awareness would help extend the potential range of permitted policy options and both charismatic narratives and striking visual imagery may help.
- Substantial deployment of human-made orbital structures has implications beyond merely the technological, impacting human relationships to space, be it the impact of light pollution on astronomers or the loss of culturally-embedded relationships to dark skies. Narratives such as Asimov's 'Nightfall' set alongside other forms of evidence can prompt surrogative reasoning about the loss of darkness.
- Fully examining the interdependencies between space policy and policies on climate and energy requires engagement between those sectors and the disciplines associated with them despite the fact that these are typically very distinct. Narrative evidence provides new ways to consider those interdependencies at different spatial and temporal scales.
- Robust approaches to space and climate require the inclusion of insights on multiple timescales, and narrative models can help point up the

consequences of, for example, using space policy to create new energy sources while not at the same time considering the underlying drivers of demand.

- As has already been seen with geo-engineering, humanities and social sciences will be essential to the early consideration of solar-based energy. New technologies create new potential options whose consequences are not simply economic. Narrative evidence points to the political and social significance of, for example, notions of energy independence and control of solar power, requiring consideration of risks and benefits over multiple societies on multiple time scales.
- Perhaps more obviously, the public visibility of a simplistic "escape narrative" as often presented in the media and adopted by significant entrepreneurs must be challenged. Alternative narratives exist: for example a story like Kim Stanley Robinson's *Aurora* enables surrogative reasoning about choices to stay, travel or return, while the film *Don't Look Up* satirises the notion of escape.
- As the report points out throughout: narratives do not simply warn or inspire, for example in the case of 'Spaceship Earth' narratives of the creation of self-contained societies, they can meticulously model future societies and thereby enable better informed debate about pathways and desired destinations. For example, narratives can enable plausible modelling of the ways in which sustainability in physically enclosed systems is dependent on different distributions of restriction and freedom to those in the UK at present, including the norms governing uses of spaces and of reproduction, and the ways in which success depends on different distribution of status and skill.

For those seeking to use any of the evidence or ideas in this summary, the report and its associated materials are intended to provide extensive support for next steps.

Contents

Introduction

The UK and space

The exploration and exploitation of space is of critical importance to the UK. Services provided by satellites are now woven into most aspects of modern life, forming the backbone of twenty-first-century civilian, defence and security communication infrastructures. Satellites enable capabilities taken for granted by much of the country such as positioning, navigation and timing (PNT), climatic and weather monitoring, and scientific experimentation. The central importance of these functions for UK, partner and competitor nations has resulted in orbit becoming a key site of geopolitical interest and contestation, closely tied to future economic growth. Responding to these opportunities has driven significant intellectual and economic investments in the UK. In 2023, the UK space sector directly employed 48,800 skilled individuals and supported 2,300 apprentices. These figures support observations that whilst the UK space sector remains small, it has established a reputation as a highly significant sector. Despite an allocation of 0.05% of GDP by the UK on space (contrasted with the US' 0.24%), global satellite services supported over 18% of UK GDP. The economic results are clear - in 2022, turnover reached £17.5 billion, adding £7 billion to the UK economy, and produced exports valued at £5.9 billion.[1] Space represents an important and emerging dimension of UK national strategy, reflective of the wider global economic landscape in which the overall space economy is forecasted to grow at 5.1% per year to 2040.[2]

Many experts are now turning their attention beyond near-and far-Earth orbits to consider the benefits and risks of deeper space exploration and extraction. The moon and Mars feature in an increasing number of state and private sector press releases and strategic documents. As these emerging opportunities are explored, new threats and barriers are uncovered: as more material enters orbit, the risks of unintentional damage by debris increase; the dominance of private sector partners

[1] *UK Space Outlook 2023: A guide to the UK space sector* (2023). Available here: https://www.adsgroup.org.uk/facts-figures/uk-space-outlook-2023/

[2] *The Case for Space: Investing to realise its potential for UK benefit* (Dstl, 2023). Available here: https://assets.publishing.service.gov.uk/media/64afdb40c033c1001080623b/the_case_for_space.pdf

leading technological developments are forcing states to re-evaluate their role and responsibilities in future space strategies.

Drawing back even further, renewed focus on space stimulates conversations on wider issues such as climate change, sustainability, and what moving beyond Earth could mean for society and culture. In the July 2023 UK Department for Science, Innovation, and Technology (DSIT) report *The Case for Space*, the benefits and challenges of the emerging space sector were described in societal, economic, scientific and inspirational terms. Building effective and impactful policies and strategies to shape these multidimensional areas of a dynamic and intersectional field such as space is a highly complex task. The use of conventional evidence forms and expertise can struggle to fully represent fields which only tangentially relate to current experiences, for example it is widely understood by legal experts that the use of maritime law for space policy is a poor proxy that may generate more problems than it solves. Despite space's appearance as a new field of study and work, many experts in the humanities have been considering the economic, political, ethical and moral dimensions of space for decades, if not longer. This prompts the core question answered in this report:

How can policymakers and strategists best harness these untapped areas of expertise and forms of evidence to inform UK space strategy?

Narrative evidence for UK space policy and strategy

Developing robust space policies and strategies requires consideration of plural, interdisciplinary and novel forms of expertise and evidence (PINE). Using a storylistening approach, this report sets out cutting-edge collaborative research conducted with academics, analysts, and private- and public-sector experts exploring how evidence from the humanities can help tackle some of the most complex space-based problems faced by those in government.

Storylistening is the theory and practice of gathering and analysing narrative evidence to inform decision-making, especially public reasoning, as part of a multi-dimensional evidence base.[3] Storylistening focuses on listening (not telling), thinking (not feeling), and collectivity (not individuality). In storylistening, 'story' is used synonymously with 'narrative'. Narrative evidence encompasses a wide range of sources including material badged as both fiction and non-fiction, including government publications and speeches, films, novels and personal accounts. Through rigorous analyses, storylistening provides access to evidence which speaks to four key functions: providing multiple points of view and new **framings**; creating and conveying insights into **collective identities**; informing and acting as **models**; and, enabling new and rigorous **anticipations** (see Box 1 for further detail).

[3] For further information on storylistening, see Sarah Dillon and Claire Craig, *Storylistening: Narrative Evidence and Public Reasoning* (London: Routledge, 2021), as well as the resources gathered on the storylistening website: https://www.storylistening.co.uk/

1. Points of View (Framing)

Storylistening provides new **points of view** to inform the **framing** of the target system and the policy debate. Narrative evidence provides an accessible way to identify the plural ways in which policy issues may be understood and communicated by identifying dominant, antagonistic, and neglected framings which - when collated - provide a more comprehensive understanding of an issue. By identifying multiple frames relating to a topic, storylistening provides decision makers with new points of view about a target system which can be supported, discounted, or mitigated, and awareness of alternative perspectives that may drive future conflicts. The benefits of the increased situational awareness of framings afforded to decision makers by narrative evidence enables increased rigour in strategic and operational planning, and greater understanding of countervoice and potential future barriers to deployment.

2. Collective Identities

Stories function to create and consolidate **collective identities**. The process of sharing stories within groups conveys social norms and embeds group coherence, building and maintaining identities and influencing behaviours. Stories provide insights into the nature of these collective identities, including how they are formed and maintained, and through their modelling in the story content. Storylistening therefore offers new ways to explore what the collective identities relevant to a particular system are, and what they mean. Decision makers need to be aware not only of traditional population groupings but the potential for highly contextualised collectives and emerging communities around key policy issues. Identifying hidden, fluctuant, or contextual communities remains a challenge for policymaking. Through robust analyses of narrative evidence, storylistening is able to deliver insights into key populations and associated behaviours around policy topics that may be overlooked by traditional understandings of the policy issue.

3. Narrative Modelling

Stories can inform and act as **models**. Studies of narratives can extend the range of plausible causal accounts of the behaviours of the complex systems that matter most to policy, expanding the 'ensembles' of models that are available with which to think and reason. Stories may be the only way of collectively thinking through the potential behaviours of complex systems in some cases. A story does not provide scientific knowledge, but narrative evidence enables surrogative reasoning about things about which there is no scientific knowledge, or an alternative approach to, and perspective on, things also known through scientific means. Storylistening provides insights and alternative interpretations which can support decision makers in developing more robust and impactful strategies through access to mimetic (reflecting an existing structure) and anticipatory (hypothesising a future structure) narrative models around a priority topic.

4. Anticipations

Storylistening enables new forms of rigorous **anticipation**. Anticipating the future, individually and collectively, is key to decisions in the present. Narrative models and narrative futures methods, complementing computational ones, can enable policymakers to consider and understand the multiple possible futures which their decision making will occupy and influence. Storylistening can contribute new anticipations of the future, enhancing the quality of current decisions by bridging from scenarios to action by highlighting to decision makers both stories about end-states (that prompt immediate action), and stories about pathways, risk, and adaptation (that prompt long-term planning).

This report draws on a combination of evidence sources: expert opinions from the project Steering Group; commissioned synthesis papers [SP*n*]; evidence from an expert workshop involving academics and policy practitioners; and novel narrative analyses.[4] Anticipatory narrative models created from futures exercises conducted during the workshop are presented in boxes titled 'Futures Box *n*'. These are presented as 'useful fictions' which offer, like those developed by Dstl, to 'spark discussion and creative insight which might challenge established thought'.[5]

Through these collection and analysis activities we identified two key intersectional problem areas - pathways and positioning, and participation and practices:

- *Pathways and positioning* considers political aspects of space policy, seen in issues of sovereignty, defence and security, and exploration, ownership, and governance.
- *Participation and practices* addresses social and public understandings and beliefs of space policy, which are explored through issues of space domain awareness, dark skies and climate.

The following sections of this report provide a brief overview of these issues and their relevance to policy, and provide examples of narrative evidence, and indications of where and how further useful narrative evidence might be gathered and analysed to inform decision making. The target audience for the report includes space policymakers, and interested, topic-aware individuals. The tools needed to read the report are contained within this document.

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[4] All of the supporting documentation is available on the 'Future Uses of Space' project website.

[5] *Stories From Tomorrow: Exploring new technology through useful fictions* (Dstl, 2023). Available here: https://www.gov.uk/government/publications/stories-from-the-future-exploring-new-technology-through-useful-fiction/stories-from-tomorrow-exploring-new-technology-through-useful-fiction

[Cover image taken from the UK National Space Strategy, 2021]

1. Pathways and positioning: the UK's place in the 21st century space race

Within a landscape of technological, social, and political change, which relationships, values, and capabilities will shape and enable the UK's future space ambitions, and how?

1.1 Sovereignty, defence and security

In 2021 the UK published an Integrated Review, titled *Global Britain in a Competitive Age* (IR21), followed by the *Integrated Review Refresh* (IRR23) in 2023. These reports set out a series of key geopolitical, economic, and technical challenges for the UK as it repositions itself in an increasingly multipolar world. Many of these decisions directly relate to space, for example whether and how to ally or partner when developing future strategic capabilities, for instance aligning with North America and foregoing some aspects of autonomy, or pursuing greater independent 'sovereign' capacities and risk isolation within geopolitical arrangements currently dominated by blocs of traditional Great Powers and collectives of emerging nations [SG]. These concerns are reflected in current debates about collective defence and security in which space plays a central role. In many cases this is further complicated by blurring of applications of technologies across civil and defence domains. In September 2021 and February 2022, respectively, the then UK government published

a pair of strategies - the National Space Strategy[6] and the Defence Space Strategy[7] - bringing together civil and defence activities into an integrated approach for the first time.

Despite clear political will, the nature and character of future space sovereignty and collaboration remains less clear. These issues must also be considered as part of a landscape which now includes rapidly accelerating private sector investment, shifting public opinion, and concerns of neo-colonial power imbalances. Navigating these complex themes requires close attention to under-represented voices and emerging ways of conceptualising uses and relationships to space. In response, this section presents a range of narrative evidence to inform decision making.

1.1.1 Narrative deficits regarding UK accomplishments

Public and political engagements with UK space strategies involve the mutual construction and consumption of narratives which often characterise and position UK sovereign space achievements as part of wider ambitions. Reviews of this evidence suggest a deficit around the narrativisation of UK space successes. Many of the dominant media narratives frame the UK as peripherally involved in space science, occupying a position somewhat in the shadow of major space powers. This is typified in the mismatched framing of success by both US and UK-based subsidiaries of Richard Branson's Virgin group. Virgin Galactic, based in New Mexico, USA, has captured popular imagination through space tourism, while the Virgin Orbit satellite launch company which aims to launch from Cornwall, UK, filed for bankruptcy in May 2023, contributing to the impression that the UK has poor capabilities in terms of launching and innovation in space satellite technology [SP2].

Notable UK-led successes such as the UK-led ESA project, Beagle 2 Mars Lander - the only British built spacecraft to have landed on another planet - and the UK's role as a partner in the GAIA mission, creating a 3D map of the milky way, remain underreported or overshadowed. The UK's contributions to the ESA Solar Orbiter mission and sovereign 'Skynet 5' military communications satellites suggest that

[6] *National Space Strategy* (HM Government, 2021). Available here: https://www.gov.uk/government/publications/national-space-strategy

[7] *Defence Space Strategy: Operationalising the space domain* (Ministry of Defence, 2022). Available here: https://www.gov.uk/government/publications/defence-space-strategy-operationalising-the-space-domain

capacity and capabilities exist, but they are not being mobilised through public narrative to shape a collective identity of the UK as part of, or independent from, other strong national space identities [SP2].

Creating new and prominent narratives around these success stories through press releases, social media campaigns, public talks or educational outreach programs, as well as managing the narratives of less successful projects, for example through nuancing via interviews with project leaders, will increase support for investment in the space sector, and improve UK positioning if seeking international collaboration. The use of narrative evidence by policymakers offers a tool through which to capture lessons from near- and full failures to build better and more robust strategies.

1.1.2 Case Study: Framing the OneWeb purchase decision

UK interest in space has driven a range of strategic investments designed to acquire or access technologies and platforms for sovereign use. In many cases, the mechanisms through which these purchases are made require interconnections which are not represented in more public framings. For example, originally a US venture, OneWeb aimed to provide high-speed internet globally via a constellation of satellites. Its bankruptcy led to the UK's partial acquisition in 2020, intending to repurpose it for space-based navigation. The UK government's keenness to establish this capacity has been linked to the end of the UK's partnership with the European Union's Galileo satellite navigation project after Brexit, and the perceived need to maintain satellite access.[8]

The narrative framing of the OneWeb purchase decision, particularly in the media, positioned the investment in terms of national pride, autonomy, and an opportunity to demonstrate the UK's capabilities in a post-Brexit context. Discussions about the event evoked the idea of a 'Great British Public' and nostalgic myths of Victorian entrepreneurship, indicating a desire to revive or maintain a perception of Britain as a leading global power.

This dominant national autonomy framing elides the collaboration between the UK government and the Indian corporation Bharti Enterprises in acquiring OneWeb. The

[8] Jonathan Amos, 'OneWeb satellite information company is officially reborn', *BBC News*, 20 December 2020: https://www.bbc.co.uk/news/science-environment-55016402

acquisition could equally be framed as demonstrating the potential for international partnerships to bridge gaps or provide resources, indicating that, while the UK desires autonomy, it is open to strategic alliances.

1.1.3 Networked sovereignty

The examples provided above demonstrate different points of view regarding the extent to which UK space sovereignty can be, or should be, considered autonomous. Previous UK policy positions in documents such as the IR21, and IRR23 sought to position the UK as a science and technology superpower, leveraging national capabilities for global influence. Reflecting on the IR21, the IRR23 specifically stated that (the UK is) '*committed to making the UK a meaningful actor in space, strengthening our civil and military capabilities,* ***supporting the growth of a sovereign UK space industry****, developing new governance for sustainable management of commercial activity in the space environment and advancing norms of responsible state behaviour*' (p.28, IR Refresh, emphasis added). It is notable that, in the IRR23, notions of autonomy and sovereignty are most often discussed in terms of international leverage, suggesting that ideas of sovereignty are understood in part by the UK's ability to connect and collaborate.

Many workshop participants questioned if the UK genuinely needs a national autonomous space presence, identifying desire for sovereignty as not necessarily helpfully framed by persisting historical narratives of UK imperial ambition. Counter-framings were offered which advanced ideas of networked sovereignty rather than isolated autonomy. Networked sovereignty highlights the role of coalition-building and collaboration in developing sustainable forms of sovereignty which may include state-, private, and civil groups. These collectives are not new, for example the UK has brought private and state-based institutions together in public-private partnerships (PPPs) for many years.[9] This could involve devolved administrations reshaping the concept of the nation-state, and evaluations of the legacy of empire.

Multiple disciplines across the space sector are engaging with the potential of new forms of networked sovereignty. From the perspective of law, intensifying

[9] *Public Private Partnerships* (HealthcareUK, 2013). Available here: https://assets.publishing.service.gov.uk/media/5a7c7835e5274a559005a152/07_PPP_28.11.13.pdf

competition means that legal proposals (such as Artemis Accords 2020) are increasingly bilateral and not global [SP1]. It may therefore be desirable for the UK to establish bilateral and smaller multilateral partnerships rather than larger networks in the context of a rising private sector. A staple of the defence and security sector, the importance of closed-loop and small-number partnerships is underlined by specific text in the UK's National Space Strategy which suggests that:

> *The UK will grow and strengthen our relationships with partners such as the US, Five Eyes, with European states and across the world, working together to solve humanity's greatest challenges, forging new bilateral partnerships, and expanding existing ones.*[10]

Eric Kotani and John Maddox Roberts's *Legacy of Prometheus* (2000)[11] is a useful narrative model that can enable surrogative reasoning about the opportunities and challenges of networked sovereignty, albeit with the centre of sovereignty located within a corporation, rather than a state. The novel is a collaboration between SF author Roberts, and Kotani - a pseudonym for astrophysicist Yoji Kondo, who headed the astrophysics laboratory at the Johnson Space Center (formerly, Manned Spacecraft Center) during the Apollo and Skylab Missions, and was the NASA director of a geosynchronous satellite observatory for 15 years, among other roles. The narrative revolves around Cash Carlson, founder and boss of Lone Star Space Systems, which is leading the race to develop space-based solar power (SBSP).

[10] National Space Strategy (HM Government, 2021), p. 32. Available here: https://www.gov.uk/government/publications/national-space-strategy
[11] Eric Kotani and John Maddox Roberts, *Legacy of Prometheus* (Forge, 2000).

Carlson is a thoroughbred Texan, exemplar of both the adventurous space frontiersman and the space entrepreneur (see 1.2.1 and 1.2.2 below). He is also exceptionally skilled in political manoeuvring.

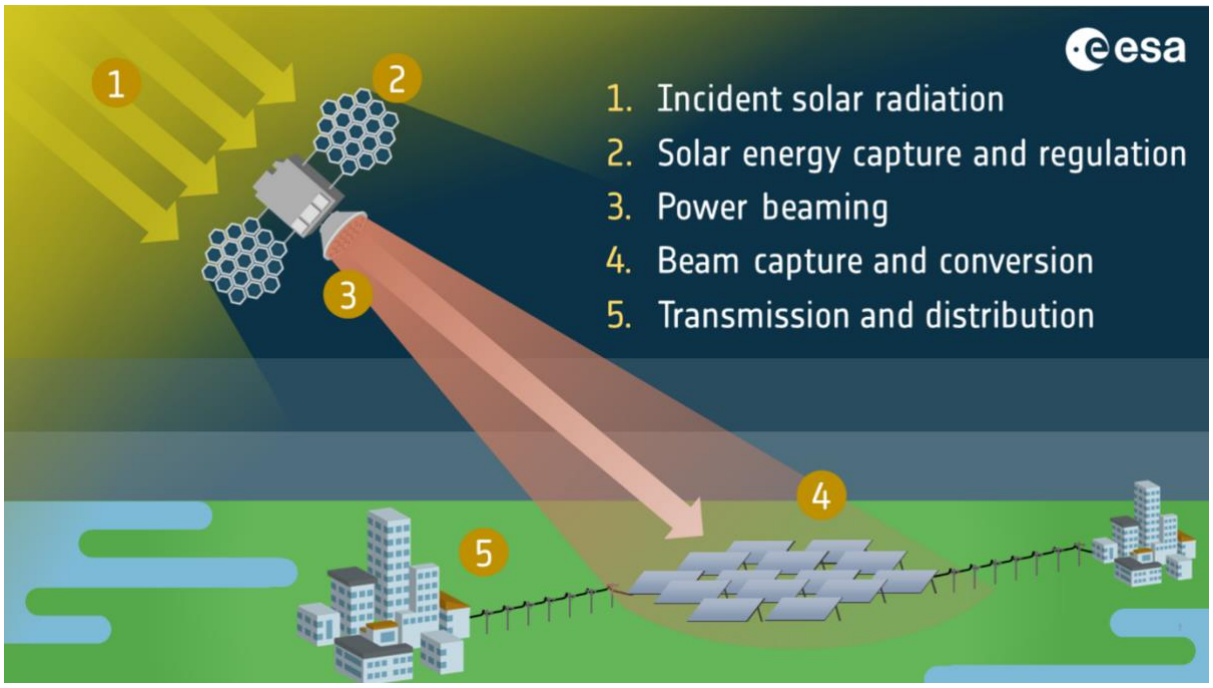


Figure 1: European Space Agency (ESA) diagram of space-based solar power (SBSP)

In order to ensure the possibility of commercial SBSP projects, Carlson joins with the other space entrepreneurs in order to defeat a proposed U.N. regulatory committee on power satellites which the corporations believe would stifle free enterprise. His method of doing so is an audacious intervention into the new post-colonial, potentially post-state, often public-private networked global landscape. Carlson's approach is explicitly situated against the backdrop of such an evolving world order in which old empires have collapsed leaving nations which have often subdivided into mini-nations and then reformed into 'modern-style confederacies'. Carlson's reading is that the new world looks very much like the United States, with the U.N. now serving the role of World Congress. Carlson's insight is that even in such a networked order, politics remains local, so his plan is to distribute involvement in, and reward from, the development of SBSP, to 'spread the interest out as far as possible' (38). Referencing the Cold War space era, Carlson contrasts the localised approach of the Soviets, focused on Moscow and in so doing alienating member states, versus the U.S. approach which carved up the space effort across a number of member states. Less efficient financially, such an approach is more effective

politically. Carlson proposes replicating this approach globally by distributing his SBSP project across multiple nations, thus appealing to a global ‘community of interest’ (p.39) in ‘abundant, cheap power’ (p.39). Note that Carlson is equally savvy in understanding that space exploration is most effectively framed in policy terms - at least at this point in time - as an issue of ‘energy and environment’ (p.70) (see 2.2 below).

Lone Star represents corporate networked sovereignty, as Carlson explains to journalists: ‘we’re not engaged here in an American project. Lone Star is primarily American, but I have investors in Japan, Russia, Europe, the Arab nations, and of course, Brazil. Getting working solar-power satellites into orbit is a worldwide project, and the whole world will benefit from it. All of us in the race feel that an open competition is the best way to accomplish this, but it has nothing to do with competition between nations’ (p.126). Such a networked enterprise is not without high risk, and the novel models how it requires extensive diplomacy, negotiation, and well-managed communications, as well ‘financial incentives’ (more or less legitimate). It is also the constant target of state and corporate competition, infiltration and sabotage. But it represents one successful way of getting things done.

Taking this story seriously as part of a synthesis of narrative evidence with regard to space policy can enable decision makers to consider the values and commitments of the different participants in space technology and policy, the perspectives that each have on the other and the tensions and practical resolutions this might require, as well as the advantages and disadvantages of diverse relationships between the public and private sector, and both between and within nations. The emergence and rapid growth of the global space sector provide a wealth of working models linking private, public, and civil organisations. Narrative evidence provides further insights into the potential nature of state-private relationships of space.

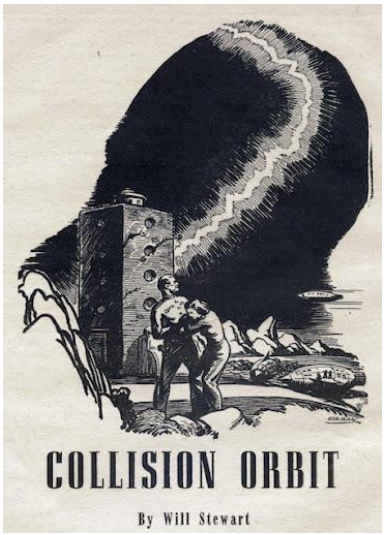
1.1.4 Anticipations of sovereignty issues in extraterrestrial colonies

Much discussion of space sovereignty is tied to contemporary operational and strategic geopolitical issues such as Russian anti-satellite capabilities and the global space skills marketplace. Alongside these terrestrial factors, the UK, partners, and competitors have maintained exploratory work on off-world living, including investments in moon settlements such as a £2.9m contract to Rollys-Royce to develop lunar nuclear power.[12] Drawing on experiences from other fields critical to the UK's national good, such as the nuclear industry and pandemic health security, it is clear that to be most effective, investments in technological expertise should be accompanied by explorations of the potential social, cultural and political risks and opportunities posed by these new trajectories. For off-world habitation, anticipatory narrative models are clear that in the long-term, new issues of sovereignty could arise in the context of a relationship between Earth and an extraterrestrial colony (on the effect of off-world habitation on individual and collective identities more broadly see 1.2.3 below).

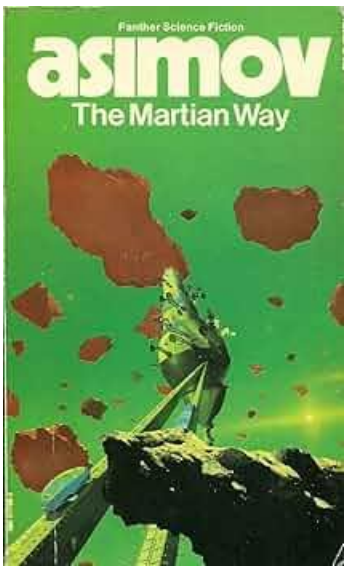
Narrative models from science fiction concerned with off-world settlement offer sites for reasoning about the conflicts and opportunities afforded by the establishment of off-world colonies [see SP3]. Anglophone SF stories such as Will Stewart (early pseudonym for Jack Williamson)'s 'Collision Orbit' (1942), Isaac Asimov's 'The Martian Way' (1952), Arthur C. Clarke's *The Sands of Mars* (1951), Poul Anderson's 'To Build a World' (1964), Robert A. Heinlein's *The Moon is a Harsh Mistress* (1966), Michael Allaby and James Lovelock's *The Greening of Mars* (1984), S.C. Sykes' *Red Genesis* (1991), Mary Robinette Kowal's *Lady Astronaut* sequence, and Kim Stanley landmark *Mars* trilogy, as well as his later *Red Moon* (2018), all model the interplanetary dynamics and questions of sovereignty that emerge in the future scenario where Earth has established off-world colonies. In such works, the colony is commonly positioned as part of a wider governmental system against which the colonists define themselves and from which they often eventually seek secession. A key recurrent theme is the ambition for independence from Earth, enabling surrogative reasoning about potential future issues of autonomy and

[12] Dan Martin, 'Government signs £2.9m Moon base nuclear power deal with Rolls-Royce', *BBC News*, 17 March 2023. Available at: https://www.bbc.co.uk/news/uk-england-derbyshire-64982477

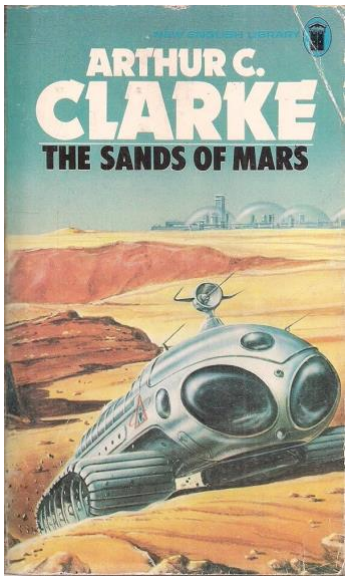
relationships to a governing centre, which hold salient lessons for future extra-terrestrial trajectories, as well as current terrestrial geopolitical decisions around autonomy and self-determination, with particular salience for defence and security policymakers.



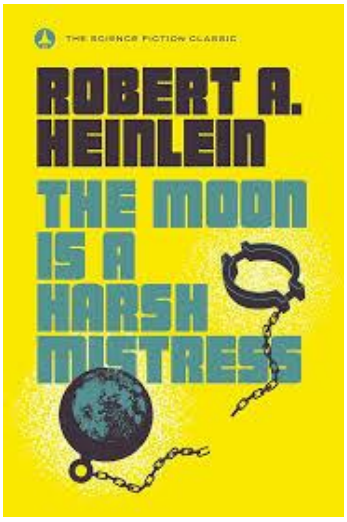
Will Stewart, 'Collision Orbit' (*Astounding Science Fiction*, 1942)



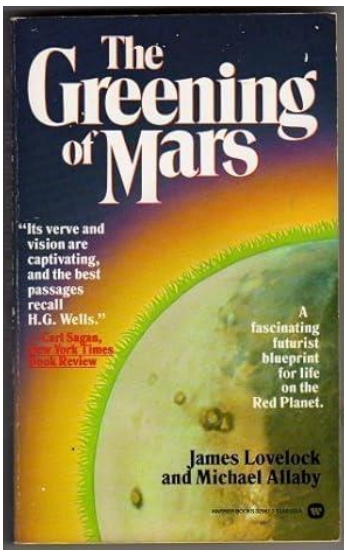
Isaac Asimov, *The Martian Way* (Galaxy Science Fiction, 1952)



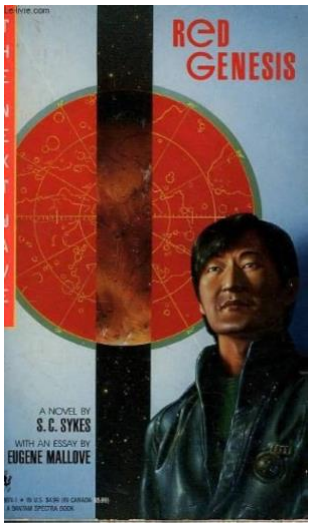
Arthur C. Clarke, *The Sands of Mars* (Sidgwick and Jackson, 1951)



Robert A. Heinlein, *The Moon is a Harsh Mistress* (G.P.Putnam's Sons, 1966)



Lovelock and Allaby, *The Greening of Mars* (Grand Central, 1984)



S.C. Sykes, *Red Genesis* (Bantam Books, 1991)

In Kim Stanley Robinson's *Mars* trilogy, a Martian colony starts to develop a distinct Martian identity which corresponds to an opposition between Martian and terrestrial

modes of governance. The narrative models an exploitative relationship in Earth ownership over Mars. Organising approaches to living on Mars solely in terms of an extractive relationship that measures success by how far the needs of Earth's industries are met overlooks essential dimensions of the Martian community's needs [SP7]. Such narrative models enable reasoning about the risks and benefits of continuing in space practices of extractive colonialism that prioritise the needs and values of the original colonisers over those of established or emerging indigenous populations. The UK Government is actively engaging with many of the ways that historical contexts such as colonial legacies continue to shape strategic geopolitics. A comprehensive narrative evidence synthesis of a range of narrative models of Earth-colony relations would contribute to this ongoing project, both in terms of modelling past terrestrial structures and anticipating future space-based arrangements.

Modelling beyond the bilateral scenario, Will Stewart's 'Collision Orbit' (1942)[13] - the short story in which the word 'terraforming' was coined - is set in a far future scenario in which the colony on a small asteroid named Obania is a legacy of early space exploration. Men from that era remain shadows of their former selves, who were defined by the frontierism of early exploration, for instance Bruce O'Banion, who had been 'a wealthy and important figure, the natural political leader of the rugged little democracy he had helped plant on this far frontier against the stars' (p.82). The old assembly hall 'where the pioneers had gathered for their simple government' is now, however, converted into 'an Interplanet warehouse' (p.82). After a significant war which ended in 2171, the Treaty of Space has enforced a new bureaucratic order enforced by the High Space Mandate. From the point of view of another of the old-timers, space engineer Jim Drake, 'The Treaty of Space had ended the world - the frontier world that he and his kind had wrested from the cold eternal night' (p.81). In its place is a complex off-world order which models questions of sovereignty beyond the bilateral Earth-Mars or Earth-Lunar. Here there are manifold centres of power at play including the military, great planet monopolies, corporations such as Interplanet, the Mandate government (a confederacy of now inhabited planets including Venus, Mars, Earth, and Jupiter), as well as individual planets

[13] Will Stewart, 'Collision Orbit', *Astounding Science Fiction* 29:5 (1942): 80-106.

acting in their own interests, for example the Martian Reich (a signifier of the story's composition during WWII). The question of sovereignty in this story is not one of a colony's independence from Earth, but of an individual asterite's (resident of an asteroid) right to independent ownership of elements of space in the face of the widespread control of big-government and big-business. It models the threat of the latter to individual entrepreneurship and invention, which in this story hinders breakthrough science and technological advancements with significant civilian and military uses. (Written in 1942, the story is curiously nostalgic for the entrepreneurial freedom imagined in an era of space frontierism which had yet to come after its publication.)

FUTURES BOX 1: Model for achieving national autonomy in UK space policy

A narrative model of a trajectory towards achieving a desirable level of national autonomy in UK space policy by 2040 begins with the National Space Strategy (NSS), Defence Space Strategy (DSS), and Defence Space Industrial Strategy (DSIS). The National Risks Register and other sources are used to assess the UK's reliance on space and develop a Space Partnership Roadmap. As the years advance, the focus will shift to identifying essential capabilities for autonomy encompassing crucial data, systems, and services. Museums will play a role in public education, while sectors like research, legislation, and industry align their roadmaps with the autonomy goal. By 2040, using tools like Global Strategic Trends (GST) and insights from science fiction, the UK will visualise and achieve a robust state of space autonomy.

1.2 Exploration, ownership and governance

The rapid development of the space sector is driving deep thought on how to bridge current and future capabilities and capacities. Space demands the application of diverse current skill sets to drive the development of new technologies, which in turn may offer potential reward in resources and services. History provides multiple examples with which to explore how national interests seek to secure and capitalise on emerging resources, and at what cost - be it industrialisation and climate, or spices and slavery. Explorations of future resources force policymakers to make decisions in the face of significant uncertainty. At these junctures it is vital to draw on PINE to begin to map not only the technical and economic natures of the landscape, but to overlay and entwine the social, cultural, and political. The UK Government is currently rethinking how this is best done across policy issues such as artificial intelligence (AI), climate change, and pandemic preparedness. These debates, as with space, consider the importance of access, ownership, rights and responsibilities. In these settings, commercial, public, and military objectives may collide. This is further complicated by considerations of whether - and how - to develop frameworks that enable exploitation for resources, or for human access in the future. The UK's position is that the 'rules of the game' for securing rights and access are still being decided. Policymakers must therefore draw on the best possible forms of evidence and expertise to shape norms and standards that may well have significant and lasting impacts on geopolitics for decades - if not centuries - to come.

1.2.1 Colonial and new framings

A strong through-line in narrative evidence on space exploration relates to colonisation. Colonial ideas, tropes, and framings dominate Western imaginings of space exploration, in particular ideas of the frontier in US space narratives and rhetoric, and maritime metaphors in UK narratives and rhetoric. The pervasiveness of such framings means space exploration is currently informed by national histories, which can induce narrative lock-in, excluding collective identities not represented or mobilised by such narratives, closing down alternative framings, and inhibiting novel anticipations. Narrative evidence can expose such framings, as well as offer

alternative points of view and framings with which to challenge these dominant narratives, reframing the issue through the incorporation of alternative points of view, representing a wider range of collective identities and their concerns, and opening up plural future scenarios.

American discourse on space frequently employs frontier metaphors, drawing on common imaginings of histories of Western expansion. Exemplified and mobilised by *Star Trek*'s 'Space: the final frontier', frontier metaphors have been used to raise popular support in the West for space exploration, to frame it as heroic and audacious, and to represent those who undertake it as collectively brave hardy, strong, persevering individuals. Frontier-focused narrative evidence has been developed and distributed by technical experts: NASA engineer and space advocate Werner von Braun employed this metaphor in 'Man in Space' (1955), an episode of the US TV series *Disneyland*, in order to connect the cultural pride of American audiences to the exploration of space [SP3]. It persists in popular cinema: for instance, in Christopher Nolan's *Interstellar* (2014), protagonist Joseph Copper, frustrated with his earth-bound farming life, observes near the beginning of the film, 'It's like we've forgotten who we are [...] Explorers, pioneers, not caretakers'. Continuing the legacy of such framing into the present day, the alternate history space drama series *For All Mankind* (2019-) develops a future in which the Cold War space race has not ended. In the series, the US builds a moon base named Jamestown in 1983, referencing the Jamestown settlement in the Colony of Virginia in the early 1600s, the first permanent English settlement in today's USA [SP6].

Just as American frontier narratives are well known and well used in US policy circles, British policymakers commonly employ maritime metaphors, drawing on the UK's history of naval exploration. These differences highlight the highly culturally contextualised use and abuse of narratives and metaphors informed by a nation's particular history. Whilst deep-rooted framings offer social and cultural anchor points from which to spur on action and drive change, they are as capable of limiting anticipations of the future and risking repetitions of historical trajectories. Narrative evidence can contribute to breaking free from these hidden narrative lock-ins, identifying alternative positions from which to develop new ways of thinking and doing space policy.

For example, Afrofuturism - which places humanity in relation to all ecosystems rather than seeking to reproduce historical paths, and which imagines futures informed by Black histories and cultures, and Indigenous Futurism - which emphasises sustainable practices and ethical considerations in space exploration - offer narrative framings for space exploration which are less centrally represented in popular media [SP6]. These are not new narratives, although perhaps they are only now receiving (renewed) mainstream attention. In 1971, American jazz composer, musician and poet, Sun Ra, taught a course at the University of California, Berkeley entitled 'The Black Man in the Cosmos'. As a result, film and TV producer Jim Newman made the Afrofuturist SF film *Space is the Place* in 1972 (released in 1974), starring Sun Ra and his The Arkestra ensemble. The film offers a radically alternative imagining of the future possibilities of space than those found in most Western mainstream narratives. In *Space is the Place*, space is imagined as the site of a utopian Black-only and Black-led civilisation where the African American is free from the repressions of white supremacy. Two of the seminal African American SF authors of the twentieth century, Samel R. Delany and Octavia Butler, produced complex narratives modelling space exploration and alien contact (see, for example, Delany's *Babel-17* and Butler's Xenogenesis trilogy). A fuller narrative synthesis of the new framings, insight into collective identities, and alternative futures to be found in Afrofuturist narrative models of space exploration would inform policymakers seeking to think about plural futures of, and future uses for, space: 'a multiplicity of other types of destinies' (*Space is the Place*).

Figure 2: Image taken from 'Space is the Place' (Janus Films, 1974)

UK funding organisations are increasingly recognising the value of including indigenous knowledge in wider policymaking, especially around issues such as environmental degradation.[14] For space, indigenous perspectives dispute that outer space is distinct from earth and that harmful effects of extraction can be externalised. These are not solely 'future problems' linked to off-world extraction; they also echo a long and painful history of colonialism and appropriation, legitimised by the devaluation and marginalisation of indigenous perspectives and expertise. Space scholars in this area point to the current annexation of Indigenous lands and displacement of peoples for the development of infrastructures or logistical projects that promote space exploration, and the disruption of cosmological links with the night sky (see section 2.1.1 for more on dark skies) [SP6]. Again, such narratives are not new. In 1987, M. Jane Young's now often-cited paper '"Pity the Indians of Outer Space": Native American Views of the Space Program', made the case that understanding contrasting Anglo and Native American understandings of space exposes the ideological dimensions of sometimes otherwise uninterrogated dominant narratives and mythologies that are used to legitimise and shape space exploration. Young contrasts the Anglo framing of space as 'outer' or a 'new frontier', with Native American perspectives, for example the

[14] *The UK and the Arctic Environment: Government Response to the Committee's Sixth Report of Session 2022-23* (UK Parliament, 2023). Available at: https://publications.parliament.uk/pa/cm5804/cmselect/cmenvaud/431/report.html

Navajo view that regards space as encompassed in 'Father Sky', 'part of a network of symbolic associations that integrates all elements of the cosmos'.[15] These different narrative framings can inform policy decisions regarding what space is, how it relates to Earth, who has right of access to space, and how one ought to best behave when there. Narrative evidence drawn from synthesis of indigenous narratives around space - some written, many oral - can contribute to the evidence base and policy discussions seeking to advocate and include indigenous perspectives in space policy, for example the first Indigenous Space Track at the National Space Society's 2023 International Space Development Conference.[16]

To develop robust and equitable policies, acknowledging the limitations of dominant framings of space exploration and considering alternative framings is vital for guiding the development of space exploration strategies more attuned to environmental and social justice and sustainability. NASA has worked towards this through activities such as the Indigenous Peoples Initiative[17] with the explicit aim of *fostering ethical and culturally relevant space for the use of Earth observations*. Without robust and meaningful engagement with indigenous knowledge and knowledge holders, policymakers risk not only developing lower quality strategy and policy, but may create further tensions such as those seen in the direct actions taken in 2014 between indigenous defenders of the sacred Mountain of Mauna Kea in Hawai'i and the developers of the Thirty Meter Telescope (TMT),[18] and in 2017 between anti-colonial occupation of the launch pad at Guiana Space Center and the French operators of European-funded Ariane rockets.[19] These examples are not limited to foreign-versus-indigenous tensions - in the UK, local groups strongly objected to permission for construction of a spaceport in Uist in the Western Isles of Scotland.[20]

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[15] M. Jane Young, '"Pity the Indians of Outer Space": Native American Views of the Space Program', *Western Folklore* 46:4 (1987)269-279; 270.

[16] https://isdc2023.nss.org/home/sessions/indigenous-space/#:~:text=The%20ISDC%20Indigenous%20Space%20Track,Indigenous%20space%20development%20and%20exploration . See also, Tony Milligan, 'From the Sky to the Ground: Indigenous Peoples in an Age of Space Expansion', *Space Policy* 63 (2023).

[17] https://appliedsciences.nasa.gov/indigenous-peoples-initiative

[18] Daniel Clery, 'New front emerges in battle to build giant telescope in Hawaii', *Science*, 367: 6475 (2020): 236-237. Available at: https://www.science.org/doi/10.1126/science.367.6475.236

[19] https://www.esa.int/ESA_Multimedia/Videos/2019/12/Europe_s_Spaceport_in_French_Guiana

[20] 'Council approves plans for controversial Uist spaceport', *BBC News*, 23 June 2023. Available at: https://www.bbc.co.uk/news/uk-scotland-highlands-islands-65985647

1.2.2 Space entrepreneurs

The UK Government has often engaged with the private sector to achieve key strategic aims. These non-state organisations have shaped many significant developments in UK history. When founded in 1694, the Bank of England was a private bank, only nationalised in 1946. Likewise, much of the UK's exploration and exploitation of Asia was conducted by a private - yet militarised - organisation, the East India Company. When considering space, a key group of actors in the field of exploration, ownership and governance are private space entrepreneurs such as Elon Musk and Jeff Bezos. Having germinated within the US political and economic system, frontier metaphors unsurprisingly shape many of the attitudes of this group. Musk's vision of establishing a self-sustaining colony on Mars directly mirrors the frontierism of von Braun and Zubrin [SP6]. Musk's entrepreneurial fronterism extends into wider policy-relevant debates through a 'backup plan for humanity on another planet' as essential to protect against the risks of potential extinction events on Earth, such as nuclear war, asteroid impacts, or environmental catastrophes [SP6; on the escape narrative, see 2.2.2 below].

The frontier metaphors associated with this group underpin pushes for rapid exploration and development, accelerations which may run counter to existing strategic policy rhythms and time scales and could require reevaluations of governmental policy timelines in relation to corporate pacings. Anticipatory narrative models of the relationship between state and corporate-driven space exploration and development confirm the pace differential with state seen as slow, laborious and bureaucratic but lower-risk, and corporate as fast, agile and entrepreneurial but high-risk. In Ben Bova's SBSP novel, *Powersat* (2005)[21] (see 2.2.1) space entrepreneur Dan Randolph drives his Astro Manufacturing Corporation to produce SBSP 'at a breakneck pace', whilst his Japanese competitor, backed by the Japanese government 'proceeded much more slowly' (p.12). In this narrative model, Randolph's speed - and early success - is based on 'avoiding funding from any government entity and the crippling regulations that came with it' (pp.12-13). Government funding is seen as 'a two-edged sword' (p.78), bringing with it too much oversight, red tape and congressional interference. However, when the Corporation

[21] Ben Bova, *Powersat* (Tor, 2005).

encounters financial difficulties, the promise of a guarantee of government backing for private loans secures the private investment needed for the company to survive. Randolph's eventual success in establishing SBSP is in the end dependent on both freedom from some of the constraints of the public sector - including a hindrance of pace, at the same time as financial and political backing from it - the new contender for President makes SBSP part of this campaign commitment to energy independence. Narrative models also enable surrogative reasoning about the drivers of pace: for state, pace drivers are public opinion and politics (including, for instance, the rhythm of political election cycles); for corporate, pace drivers are primarily finance, technological success and market competition.

1.2.3 Anticipations of extraterrestrial human collective identities

Narrative evidence on space provides access to cross-cutting thematic discussions around identity and belonging. As the benefits and threats of space move closer to the day-to-day lives of civil society, societies may respond by reshaping themselves in new - and possibly unanticipated - ways. Anticipatory narrative models enable surrogative reasoning on this topic as new collective identities are often imagined as forming in (and as a result of) a different extraterrestrial context. Isaac Asimov's novella *The Martian Way* (1952)[22] imagines how life on Mars leads to a unique collective identity known as 'the Martian way' distinct to that of 'the Earth way', which comprises different forms of work - for instance, scavenging is a key part of the Martian way, salvaging jettisoned fuel shells from Earth flights. When Earth threatens to withdraw its provision of water for Mars, the colony is prompted to evolve its collective identity and group-think beyond 'the Grounder way'. Rather than looking back and resorting to militaristic attack of Earth to seize water, the Martians look outwards towards deriving water from a different space source instead, severing 'the umbilical cord that ties Mars to Earth' (p.27). They are also prompted to reconsider the officially designated length of time a human being can spend in space, with the six months stated in the *Handbook of Space Flight* based on 'data compiled by Earth scientists from experience with Earth pilots and spacemen' (p.29),

[22] Isaac Asmiov, *The Martian Way* (Panther, 1974).

which does not apply to Martians who can, it turns out, in fact endure longer periods of flight.

The Martian collective identity is also defined by a heightened awareness of ecological issues and of sustainability. Their economy is not just based on the recycling of materials that Earth's space flight discards; their collective concern with sustainability is defined against that of the wastefulness of previous Earth dwellers: 'our ancestors burned the oil of Earth madly and wilfully. They destroyed its coal recklessly. We despise and condemn them for that' (p.16). In contrast to the Martians' careful sustainability practices, Earth's collective identity in the present is being mobilised by a populist political figure named Hilder. His attack on the Martians is based on a financial claim on the shells salvaged by them. He mobilises a collective identity of Earth-based opposition to continued Martian investment through a narrative regarding lack of return on public spending - 'that's what the taxpayers of Earth are really interested in - tax money out; nothing in' (p.15). He also constructs a narrative regarding the need to protect Earth's water resources despite the data showing that they are not in fact under threat from the Martian colony's allotment. This latter narrative is designed to deflect blame for ecological disasters on Earth onto the Marians, whom he frames as 'Wasters'. Stories such as this offer anticipatory models of how new forms of space industry and the development of new technologies might create new collective identities, exploring the consequences such identities might have for future issues of exploration, ownership and governance.

1.2.4 Extraterrestrial architecture and environmental adaptation

Narrative evidence on space not only describes social change, but in many cases also engages with ecological and physical engineering. For some time the UK has focused significant attention on technological modifications of biological and ecological systems, for example macro-scale geoengineering[23] and micro-level engineering biology.[24] Space narrative evidence lends insights to these and other policy areas through a range of metaphors and models, including specific consideration of planetary-scale modifications such as terraforming. Terraforming stories anticipate the importance of adapting to extraterrestrial environments rather than attempting to replicate Earth's infrastructure. Novels about interplanetary dynamics suggest that the failure to respond to the new contexts of Lunar and Mars colonisation often results in the diminishment and eventual failure of the colonies. These stories model some of the difficulties in maintaining colonies on other worlds that require suitable infrastructural connections and influxes of new arrivals [SP7]

Such narrative models might prompt reasoning about new forms of governance that are distinct from existing structures. Over a decade ago, a UKRI-funded, policy focused project explored the potential for Climate Geoengineering Governance (CCG)[25] which fed into the House of Commons Science and Technology Committee enquiry into the regulation of geoengineering. The project led to the development of the *Oxford Principles*[26] which advocated five key guiding items: that geoengineering be regulated as a public good; public participation in geoengineering decision-making is necessary; disclosure of geoengineering research and open publication of results should be standard; assessment of impacts should be independent; and, governance must be developed before deployment. The CCG project aimed to provide a timely basis for the governance of geoengineering through robust research on the ethical, legal, social and political implications of a range of geoengineering approaches. When considering the urgent need for PINE to inform political decision making on a topic as complicated as geoengineering, it is notable that of the twenty-

[23] *Geo-engineering: the government's view* (Gov.uk, 2020). Available at: https://www.gov.uk/government/publications/geo-engineering-research-the-government-s-view
[24] *National vision for engineering biology* (Dstl, 2023). Available at: https://www.gov.uk/government/publications/national-vision-for-engineering-biology/national-vision-for-engineering-biology
[25] https://www.insis.ox.ac.uk/geoengineering-governance-research
[26] https://www.oxfordmartin.ox.ac.uk/geoengineering

six working papers and seven briefing notes, several employed social science methodologies whilst none were rooted in humanities research. The CCG emphasises the benefits of accessing the expertise of architects, anthropologists, ethnographers and engineers who can identify how distinct environmental conditions could shape social relations; in these circumstances narrative evidence can be used to address these deficits and enhance policy making and strategy development.

Whilst such evidence can be found in particular in anticipatory narrative models of terraforming and its social and wider effects [SP7], narrative evidence also demonstrates how 'the built environment, on or off of Earth, supports the rights and responsibilities of those who use it safely' [SP4]. Design and psychology are intimately related (as is clear in the modern day, for instance, in the field of Human-Computer Interaction). In psychology, 'affordances' is the name given to the way in which the design of objects can suggest to the user the intended use or function of it. In everyday life, as well as in space, affordances can impede or enable life, flourishing and, in the most extreme cases, survival. 'Built architecture is what guarantees rights and constructs them into material reality' [SP4]. Elvia Wilk's short story 'Love Island' (2022) serves as a reminder that 'in space, everything is architecture [...] in space, you can only live if you build something, and there's nothing around you except what you build. Just building. The building itself and the act of constantly building it'.[27] Space architects might be expected to be bound by the same sets of duties as those on Earth (for instance those laid out in the US NACRB's *Model Rules of Conduct*) included amongst which is being judged by a 'standard of care' equivalent to that which governs the behaviour of other professionals such as lawyers and doctors. Inserting an ethics of care into narratives about space architecture and environmental adaptation changes the tone and focus of many dominant narratives of efficiency and extraction.

This has policy implications for ownership and governance, for instance regarding a need for international collaboration to standardise space architecture so as not to inhibit survival. The plot of the film *Gravity* (2013), despite its many scientific

[27] Eliva Wilk, 'Love Island: The perks of offworlding', *Grow - The Equity Issue* (2022). Available here: https://www.growbyginkgo.com/2022/04/01/love-island/

inaccuracies, models well the challenges of non-standardisation for astronauts, as protagonist Dr. Ryan Stone engages in a series of spatial interactions, struggling with hatches, airlock doors and entry portals because the hardware was manufactured by at least three different countries (Russia, United States, and China). Further-far-future anticipatory narrative models of care in space that challenge dominant narratives can be found in the novels of Becky Chambers, in particular for instance in the novella *To be taught if fortunate* (2019), the title of which comes from the opening recording of Kurt Waldheim, then Secretary-General of the United Nations, on the Voyager Golden Record, launched into space in 1977:

> *I send greetings on behalf of the people of our planet. We step out of our solar system into the universe seeking only peace and friendship, to teach if we are called upon, to be taught if we are fortunate. We know full well that our planet and all its inhabitants are but a small part of the immense universe that surrounds us and it is with humility and hope that we take this step.*

In Chambers' novel, space exploration is governed by a radical code of care and non-intervention which extends to the space explorers somaforming their own bodies to adapt to the environments of other planets rather than terraforming the planets to suit the needs of their human bodies. An earlier example of this ethics of care narrative is to be found in Naomi Mitchison's 1962 novella *Memoirs of a Spacewoman*.

2. Participation and practices: space and society

How can domestic and international populations, private sector interests, and global challenges be included in the development of cross-cutting space policies to address the UK's current and future needs?

2.1 Space domain awareness (SDA) and dark skies protection

Policymakers are well accustomed to discussions of environmental contamination and destruction. As with terrestrial and marine ecosystems, the increasing prevalence of space debris is forcing attention onto questions of national and international care for off-world environments. The UKSA has a dedicated line of work around ClearSpace which published a discussion of the future impact of space debris on global industries.[28] It suggests that advanced technical societies have 'so far, failed to meaningfully address the scale of accruing orbital debris'. The UKSA

[28] 'Future impact of Space Debris on Global Industries' (ClearSpace, 2023). Available at: https://space.blog.gov.uk/2023/12/14/future-impact-of-space-debris-on-global-industries/

now considers space debris a sustainability risk accelerated by private space entrepreneurs who compound debris levels by launching unprecedented numbers of new satellites into orbit. In earth orbital space, increasing levels of use bring the inevitable challenges of potential harm due to collisions or other aspects of operation, and choices about responsibilities with respect to debris and end of life operations. These in turn raise questions about future regulation that might form, in effect, rules of the road, and which would require policy agreements and regulatory infrastructure. The European Space Agency has adopted a unilateral target of Zero Debris by 2030, but such an approach, and any regulation, inevitably increases the cost of operations and shifts costs between current and future users and between sectors. Pointing to the power and use of narrative evidence in discussions of space debris, the UKSA specifically references a narrative model - the animated film *Wall-E* (2008) - to highlight the seriousness of the issue: 'it becomes an absolute necessity that the Wall-E predicted orbital dystopia remains a fictional fate envisioned by Pixar animators, and not a circumstantial rendering of the future for humanity's presence in space'. Rigorous incorporation of narrative evidence can contribute, alongside scientific evidence, to a pluralistic evidence-base to inform public reasoning in these two areas of active space policy, areas which are not just scientific issues but also political, social and cultural.

2.1.1 Raising public space domain awareness

Many of the policy documents relating to space debris focus primarily on technological threats such as risks to active satellites,[29] and on technological solutions such as ClearSpace, and Astroscale's £4 million award to design missions to remove existing pieces of space debris.[30] These technocentric framings risk siloing the threat of debris as an 'infrastructure problem', or only a threat to those humans in space, rather than as a potentially significant disruption to the daily lives of people on earth.

[29] *Case Study: Sustainability* (UK Space Agency, 2024). Available at: https://www.gov.uk/government/case-studies/space-sustainability

[30] 'UK builds leadership in space debris removal and in-orbit manufacturing with national mission and funding boost' (UK Space Agency, 2022). Available at: https://www.gov.uk/government/news/uk-builds-leadership-in-space-debris-removal-and-in-orbit-manufacturing-with-national-mission-and-funding-boost

A narrative evidence synthesis of textual narratives relevant to space debris demonstrates how narratives can model the impacts of space debris in a different mode to that of scientific communication or media coverage and in doing so offer new framings of the issue, suggest its impact on - and raising awareness within - a range of different collective identities, and prompting anticipatory thinking about potential future pathways and the contemporary actions that might lead to them [see SP6 for just such a short synthesis of relevant narrative evidence]. Such a synthesis draws on evidence from James White's early short story 'Deadly Litter' in which littering space is framed as a despicable crime, through to the feature film *Gravity* (2013) which, although as noted above has some significant scientific errors, in its representation of the possible consequences of a space debris generation cascade, effectively models the threat of space debris to telecommunications-dependent systems and to the safety of astronauts [SP5]. Reception and discussion of textual narrative evidence can also generate additional narrative evidence, for example it can prompt new anecdotes from imbibers who also have first hand experiences [SP5]. Narrative evidence to improve public reasoning about space debris might also usefully be drawn from non-Western sources, such as the Japanese manga *Planetes* (1994-2004) and its anime adaptation, which was developed with scientific input from the Japanese space agency, JAXA [SP5]. *Planetes* 'explores the framing of space from the point of view of commercialisation, globalisation, equitable distribution of resources, and exploration' [SP5].

The travelling art installation and exhibition *Our Fragile Space* by photographer Max Alexander frames space debris as an immediate threat to everyday life, displaying both the successful integration of satellite technology within current society, and the threat it poses to it, as demonstrated by growing evidence of debris accumulation and impact damage, as well as cultural damage associated with dark and quiet sky losses. The exhibition's employment of visual imagery, accompanying descriptions and guest essays results in a more accessible form of public communication than quantitative models, framing the issue as a public problem. This helps make a remote issue more tangible, which can increase urgency and public support for space debris mitigation policies [SP5].

Our Fragile Space was originally funded and developed with support from the University of Warwick's Habitability Global Research Priority fund and Centre for Space Domain Awareness, demonstrating that narratives can effectively be produced by interdisciplinary research initiatives, which also benefit from the inclusion of narrative experts who can effectively analyse and synthesise narrative evidence, such as within the Global Network on Sustainability in Space (GNOSIS), which brings together science and humanities academics, industry and policymakers. [SP5]

FUTURES BOX 2: Model for space debris prevention

New regulations are initiated at the national level by 2030, then progressively expand to gain international consensus and acceptance. A decade later, by 2040, these regulations are fully implemented globally. Central to this progress is the reliance on accurate tracking data and quantitative evidence that demonstrates the severity and extent of the problem. A coalition of narrative-builders, including publishers and blockbuster producers, play a critical role in reshaping the public's perception. These narratives counter the 'endless space' narrative, emphasising that space is not an infinite resource free from human-made clutter. This shift in storytelling heightens awareness of the potential impacts of space debris on future space missions and satellite operations. Fictional individual narratives set within future scenarios further convey risks and challenges through popular media. These stories, along with docu-dramas, not only inform publics but present a clear picture of the reputational risks associated with irresponsible space activities, holding key actors (including private entrepreneurs) accountable. By appealing to entities' self-interest and highlighting potential consequences, the narratives foster a collective drive to address the space debris issue.

FUTURES BOX 3: Model for space debris mitigation

A disaster narrative captures attention and urgency, leading to expert discussions that dissect the issue and propose potential solutions. After these deliberations, consultations are conducted for broader input and feedback. A consensus is sought, paving the way for the development of regulatory guidelines. These guidelines evolve into enforceable hard laws, shaping the trajectory for future space operations. Alternatively, technological advancements could offer solutions, bypassing some of these stages. Another path involves individuals or organisations taking initiative and responsibility, spurring discussions that, after consultations, lead to consensus and, subsequently, legal narratives that crystallise into hard laws. Throughout this process, narrative evidence is introduced post expert discussions to inform and shape the emerging consensus.

2.1.2 Framing and modelling dark skies

The existence of human-made orbital structures, material, and materiel has implications beyond the functional infrastructure of space. The issue of dark skies highlights how cultural relationships with space as viewed from Earth can have profound and often unheard impacts around the globe. Whilst there are few textual narratives modelling dark skies, Isaac Asmiov's short story 'Nightfall' (1941)[31] has been drawn on as an 'inverted model' [SP5] to aid reasoning about dark skies protection. Set on a fictional planet with three suns, the story takes place at the moment that occurs every two thousand and forty-nine years when only one sun remains in the sky, and it is fully eclipsed for half a day. Surviving records show that repeatedly at the same time interval, the planet's then civilization is entirely wiped out by fire. The planet's inhabitants have not developed and deployed artificial light sources because one of its suns is always shining; they therefore also have no experience at all of darkness. The story's imagining of the madness that sets in when beings never exposed to darkness lost their light entirely might usefully provide an inverted model of the effects on human beings (as well as non-human animals) of constant exposure to light and the loss of darkness entirely. The witnessing of the stars that is enabled by the eclipse causes spiritual ecstasy or further madness, depending on the individual's beliefs. This might prompt surrogative reasoning regarding the effects of loss of access to witnessing the stars in humankind, but also correlates with some already real life experiences, such as the anecdote that light pollution is so pervasive in Los Angeles that during a blackout alarmed residents called the police to report a liquid like substance had taken over the sky, unable to recognise the Milky Way.

The issue of dark skies protection is part of a larger cluster of intersecting policy issues around light pollution and its effects more generally [SP5], as well as having differential effects - as modelled in 'Nightfall' - depending on the beliefs of different collective identities [see 1.2.1 on the disruption to Indigenous people's connection to the cosmos]. Recently scientists in the explicit mode of issue advocates have deployed narratives to mobilise public awareness and policy response to dark skies pollution [SP5]. The March 2023 Dark Skies *Focus* edition of the peer-reviewed

[31] Isaac Asimov, *Nightfall and Other Stories* (Fawcett, 1969).

science journal *Nature Astronomy* contains an opinion piece on space as a shared environment and heritage. This piece posits an alternative to narratives of colonisation through stories which foreground shared heritage, such as the origin stories of the Big Bang theory or millennia-old sky traditions. From policy and geopolitical perspectives these are highly relevant as they show clear linkages to ideas of shared heritage invoked by the 1967 UN Outer Space Treaty. Another article in the Dark Skies *Focus* edition uses the term ‘big light’, deployed rhetorically to invoke analogies with ‘big tobacco’ and ‘big pharma’ to critique profit-driven corporate decision-making. Such narrative and rhetorical framings, whilst carrying benefits of reframing the problem for a new range of collective identities, also risk prompting an emphasis on regulation, rather than on mitigation of the problem.

2.2 Climate

The development and deployment of effective space policies provides decision makers with new tools to address complex global problems such as climate change. Collaborative networks such as Space4Climate[32] provide the UK Government with a forum linking the UK Space Agency, industry and academic experts to develop satellites, analysis and exploitation of data to deliver 'quality assured global data and climate services'. In the 2023 National Space Strategy in Action[33] report, the second delivery point explicitly focuses on the need to 'fight climate change with space technology'. In recent years these ambitions have crystalised into projects such as the European Space Agency's (ESA) Traceable Radiometry Underpinning Terrestrial- and Helio- Studies (TRUTHS) space climate laboratory which will set the standards for satellite climate measurements, and invest in the Microcarb joint mission with France delivering the first European satellite dedicated to measuring atmospheric CO2.

These successes can serve to hide the other side of the relationship between climate change and space policy. For instance, whilst satellite technologies play a crucial role in monitoring and analysing global climate patterns, space launches have detrimental environmental impacts. Narrative evidence enables rigorous anticipations, suggesting that as nations and private entities vie for space dominance, the deployment of space-based solar power and asteroid mining could both mitigate and exacerbate Earth's environmental challenges. Policymakers are faced with decisions regarding how satellite technologies will be harnessed for climate monitoring, the environmental impact of space launches, and the potential of space-based solutions.

[32] https://space4climate.com/

[33] *The National Space Strategy in Action* (HM Government, 2023). Available at: https://assets.publishing.service.gov.uk/media/64b7f7dd2059dc00125d25da/national_space_strategy_in_action.pdf

FUTURES BOX 4. Model for managing CO2 emissions in space projects

The first steps involve dialogue and strategic considerations, particularly focusing on space security in the next two to three decades. Various actors, from government officials and space scientists to international bodies, collaborate to discuss future forecasting scenarios. After these discussions, there is a consultation on environmental issues and a draft Impact Assessment (IA). An important part of this phase is the recognition of past mistakes, such as the European carbon pricing issues. This will lead to the introduction of the first CO2 law, which prevents high CO2 emission projects. Public reaction follows, prompting further IAs to gauge the effectiveness of the new regulations. Industry pushbacks, especially from satellite operators, are anticipated. Following on from this, a second CO2 law segments space activities into three CO2 allocations: high, medium, and low priority. This means not all space activities can proceed. The final goal is that environmental needs are addressed, CO2 footprints reduced, and the UK positions itself as a global leader in managing space-related CO2 emissions.

2.2.1 Space-based solar power (SBSP)

In 2023 the UK Government ran an open competition to develop four aspects of Space-Based Solar Power (SBSP)[34], awarding £4.3 million to groups exploring technologies that can collect solar power in a high earth orbit and beam it securely to a fixed point on the earth to deliver a clean baseload energy day and night throughout the year.

Corporate, academic and media announcements of, or accounts of, SBSP invariably open with reference to its origins in science fiction, in particular, one specific story, Isaac Asimov's 1941 story 'Reason', in which energy from the sun is harnessed in space, with microwave beams directed to earth (and other now human-inhabited planets) to meet its energy needs. Reference to Asimov's story is usually brief - closer attention to it reveals that, other than imagining SBSP for the first time, it does not provide further relevant narrative evidence. With regard to SBSP, it might be understood to be modelling some of the contemporary scientific challenges - for instance creating and maintaining beam alignment - but really, SBSP just provides a backdrop for the story's more detailed modelling of something unrelated, which, as its title indicates, is the problem that logical reasoning can be used to 'prove' almost anything, if the right premises are chosen.

Narrative evidence regarding SBSP might be more usefully derived from a different Asimov story, 'The Last Question' (1956), in which SBSP is also mentioned. The story is constructed as a series of short sections - the first set in 2061 - which each jump further forwards in time, first by a couple of centuries, then by twenty centuries, ending at the time of the heat death of the universe. The ability of stories to model across large time scales is particularly useful in relation to climate change and anticipation. 'The Last Question' prompts reasoning not about SBSP in particular, but about the sustainability of constantly seeking new sources of energy without reflection on, and adaptation of, the modes of living driving high energy consumption. The story models the dangers of continually focusing on new energy

[34] 'UK shoots for the stars as space-based solar power prepares for lift-off' (Department for Energy, Security and Net Zero, UK Space Agency and the Rt Hon Grant Shapps, 2023). Available here: https://www.gov.uk/government/news/uk-shoots-for-the-stars-as-space-based-solar-power-prepares-for-lift-off

sources without reflecting on the factors - for instance unlimited population growth - that generate the energy requirements.

The story opens with two drunk technicians on the day that the transfer to solar energy is made. One, Alexander, celebrates 'All the energy we could ever use, forever and forever and forever.' The other, Bert, observes that this is only until the sun runs out. That may be billions and billions of years, but it's not forever. And it's a time scale that is travelled swiftly through Asimov's temporally spanning narrative model. The extrapolation into the far future also enables modelling of the fallacy of the escape narrative (see 2.2.2) in the absence of contemporary behavioural change, since in the third section, twenty thousand years ahead of 2061, the characters are still facing the same problems as in 2061, but on a larger scale: 'You know the Galaxy will be filled in five years at the present rate of expansion'.

More recent narrative models of the political, social, environmental, and commercial drivers and challenges of SBSP include *Legacy of Prometheus* [see 1.1.3] and Ben Bova's *Powersat* (2005) [see also 1.2.2]. Bova was President of the National Space Society and worked as a technical writer for Project Vanguard in the 1950s. Similarly to *Legacy of Prometheus*, *Powersat* is centred on a charismatic engineer and entrepreneur, Dan Radolph. It follows his determination to successfully institute SBSP, despite sabotage attempts from a secretive conglomerate of non-Western actors determined that the USA will remain dependent on their oil and gas reserves, and complex navigation of US politics and public opinion, including opposition from environmentalists. The novel enables surrogative reasoning about SBSP beyond the technical: political commitment to space policy is mobilised by framing space as an issue of energy, not merely 'playing in outer space' (p.59), and an issue of the geopolitics of energy, since SBSP is presented as key to energy and therefore broader independence from oil producing nations.

As more and more nations across the world are turning to SBSP as a solution to energy needs, and NASA publishes a report on its economic feasibility,[35] narrative evidence can usefully form part of a developing, pluralistic evidence base to inform

[35] *Space-Based Solar Power* (NASA, 2024). Available at: https://www.nasa.gov/wp-content/uploads/2024/01/otps-sbsp-report-final-tagged-approved-1-8-24-tagged-v2.pdf?emrc=744da1.

public reasoning and decision making around its wider opportunities and risks, not just technical and economic.

2.2.2 The escape narrative

One aspect of caution around SBSP is that investment would be diverted from terrestrial renewable energy sources. The same caution applies to the charismatic narrative of space exploration providing a more permanent solution to the existential threat of ecological crisis by moving off-world and escaping Earth, a narrative often found in the framings of space entrepreneurs such as Elon Musk and Jeff Bezos [see 1.2.2]. Jeff Bezos has been heavily influenced by Gerard O'Neil, a professor of Physics whose book *The High Frontier* (1978) explores off-world living. Bezos cites O'Neil as a source of inspiration and explicitly aims to follow his call in moving heavy industry off Earth [SP2]. This is evident in Bezos's 'Blue Origin' company images which resemble O'Neill space colonies, and the colonies have been likened to the Frontier imaginary of settler USA [SP2]. The idea of large-scale space migration for humanity is a strong narrative that is evident in the cultural portrayals of space activity and has captured the imagination of the world's leading commercial space companies.

The climate emergency and collapse of major ecosystems has the potential to fuel a 'space rush' in which space entrepreneurs actively promote space colonisation as a response to planetary environmental catastrophe and resource loss in an extension of the extractivism and colonialism of terrestrial capitalism. This narrative frames off-world settlement and resource extraction as an inevitable step in humankind's trajectory based on expansionist logic: 'a desirable, capital-driven solution to both resource conflict and planetary limits' [SP3]. In *The Overview Effect: Space Exploration and Human Evolution* (1987), Frank White in fact frames humankind's eventual departure from Earth as a continuation of human evolution akin to the transition of the 'explorer fish' from ocean to land [SP3]. The dominance of this narrative may represent a growing issue of concern to policymakers seeking to mobilise the public around terrestrial climate mitigation and adaptation strategies.

Whilst popular Western narratives - such as *Interstellar* (2014) - can contribute to the escape narrative, other narratives can usefully model the challenges and

weaknesses of the escape narrative. Such narratives can be found in the new framings offered by Indigenous stories for instance [see 1.2.1], but also in further Western narratives. Kim Stanley Robinson's *Aurora* (2015) prompts its readers to consider possible policy responses to climate change in the context of space. One is the relocation option; the other is the resource management and collective governance option. These correspond to the escape narrative, and the Spaceship Earth framing [see 2.2.3]. The escape narrative is imagined in detail, drawing attention to: the levels of scientific achievement that would be required to relocate a proportion of the human population to a potentially inhabitable planet – assuming humankind could be sure enough in advance that it really would be; the amount of time it would take to do so; and the potential consequences on arrival. The novel follows the story of a group of human beings who inhabit a large, life-sustaining ship which, generations earlier, left Earth in search of a new planet to inhabit. When the ship and its inhabitants do arrive at Aurora, their joy at reaching land is short-lived when their immune systems are unable to cope with an Auroran virus. Many die of the virus; the others who have been down to the planet are murdered in an act of civil disobedience when their re-entry to the ship is opposed. Discovering that Aurora is uninhabitable, the population of the ship is divided over what action to take next. Roughly half want to stay and attempt to inhabit a neighbouring planet,the other half want to return to Earth. The population divides, and the story follows the group that return to Earth. The implication – although the reader never does find out for certain – is that those who stay will not survive. Those who survive and return to Earth find that terrestrial mitigation strategies have been making significant progress in their absence. *Aurora* provides a narrative model of the escape narrative that enables reasoning about its viability as an option in the target system, contemporary Earth.

The film *Don't Look Up* (2021) ridicules the escape narrative as a doomed back-up plan of irresponsible elites. The film uses the predicted devastating effects of the Comet Dibiasky to represent the impact of climate change. After failing to responsibly address the crisis, as would be appropriate to their respective public positions and power, US President Janie Orlean and billionaire tech mogul Peter Isherwell flee Earth on a 'space ark', along with other members of the ultra-rich. In a mid-credits scene, the ark lands on a new planet, 22,740 years later. The triumph of having survived the trip without significant losses is short-lived, as the native

carnivores dispatch the President and, it is implied, will shortly do the same with the others. In its deployment of absurdist comedy and incisive satire, *Don't Look Up* diffuses the idealism of the escape narrative, providing publics and decision makers with a different point of view on its viability.

Such far future anticipations can aid reasoning in the present. Asimov's 'the Last Question' [see 2.2.1] represents far future decision-makers facing the same pressures as now, just on a (literally) more universal scale. In doing so, it enables reasoning about what drives the constant demand for further power sources, and about the viability of off-world expansion as a solution to population pressures in the absence of other forms of societal change. Frederik Pohl's 1979 novel *JEM: The Making of Utopia*, in which SBSP also features, offers a similar narrative model of the weaknesses of the escape narrative, in which the discovery of another habitable world might mean salvation for three fiercely competing power blocs in a resource-deprived twenty-first century, but in fact the move simply exports existing rivalries and tensions off-planet. Both narratives enable decision makers to consider whether space in fact offers the relief from contemporary pressures that some narratives present it as doing, if contemporary logics and modes of living are simply extended in space and time [SP3].

2.2.3 The Spaceship Earth framing

The concept of 'Spaceship Earth' found in several narrative forms frames the relationship between space technologies and the climate in a way that centralises ecological issues as contained and constrained by a shared habitable entity - Earth. Spaceship Earth constructs our planet as a self-contained, self-supporting vessel with limited resources travelling through space. The term emphasises the finite nature of Earth's resources and the need for sustainable practices to not exhaust limited reserves. By centralising the Earth in this way Spaceship Earth counters the escape narrative that suggests that humans can simply move to a 'planet B' if Earth becomes uninhabitable. It challenges the mindset of extractivism, deeply rooted in shared global histories and the persistence of colonial power in multiple structures, promoting a holistic view of the planet as encapsulated by the iconic 'pale blue dot' image portraying Earth as a tiny speck in the vastness of space. This perspective

emphasises ecological interconnectedness and the importance of resource management, echoing other moves towards plural intersectional models in UK policy such as One Health.[36] Space technology aids the awareness of Spaceship Earth by monitoring and mapping environmental changes at local and global scales, for example drawing attention to the effects of launch sites on local communities, both human and animal. Spaceship Earth further highlights the terrestrial benefits of key UK strategic areas of space research such as geoengineering and SBSP, as well as innovations geared towards sustainability.

Kim Stanley Robinson's *Aurora* [see 2.2.2] models the Spaceship Earth framing and provides narrative evidence to aid reasoning around policy issues such as resource management and collective governance. It does so because the relocation ship on which its Earth escapees are based serves in fact as a model of Earth – it has different zones, inhabited by different peoples, different traditions and practices, different flora and fauna, and local leadership structures. It is also an entirely closed system – all its energy, minerals, metals, food, waste, are contained within it. Meticulous management of its resources and communities is necessary in order for the ship to continue to sustain life. Both scientific and humanistic expertise is needed here, as well as collective governance which ensures all the ship's inhabitants are cognisant of the need to maintain their environment through their individual and collective actions. Such governance is not idealised – while its aim is to be as democratic as possible, the novel does not shy away from modelling the way in which the sustainability of their environment is also dependent on the restriction of some individual freedoms, for instance, the right to reproduce, or to travel in certain areas of the ship. In recreating the closed system of Earth on an imagined interplanetary relocation ship, *Aurora* models the resource and governance challenges and options that Earth currently faces, and in relation to which space exploration offers both potential solutions and has its limitations.

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[36] *Public health and climate change: a One Health approach* (POST, 2023). Available at: https://post.parliament.uk/research-briefings/post-pn-0701/

Launchpad

For those working on policy on space, or in fields where space potentially plays a major role such as economic growth, energy and climate, this report has presented plural, innovative and novel evidence to inform your next steps. Through the associated materials, sources and identification of experts, we have provided practical support for the transition to implementation.

For those interested in urgently finding new ways to supplement existing forms of evidence in any significant area of policy and public reasoning, we offer this report and its associated materials as proof-of-concept. They illustrate ways to seek out, create and use PINE that are transferable across policy domains and academic disciplines.

We wish you well whether you choose to travel, settle, or stay on Earth.