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From the Sky to the Ground: Indigenous Peoples in an Age of Space Expansion

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ABSTRACT

This paper will argue that there are pragmatic reasons to further cooperation between Indigenous peoples and space agencies, exemplified by Navajo-NASA cooperation. These pragmatic reasons rest upon an argument from belonging: space expansion involves a series of multi-generation projects. The significance of our contributions to these project will depend upon the actions of other generations who are unlikely to accept goals which are idiosyncratic, rather than drawing upon some deeper human concern with space. Such concern can be informed through Indigenous inclusion. The paper will remain officially neutral about a broader range of discourses concerning land rights, sovereignty, and attempts to situate dissent as resistance to colonial settler states. It will, however, presuppose a broad sympathy with Indigenous predicaments and group survival. The approach will be pragmatic in the sense that three nonarbitrary constraints/adequacy conditions will have to be met: (i) the overall approach must be geared to policy discussions rather than counterculture; (ii) Indigenous knowledge must be acknowledged as more than ecological, in order to be relevant to the matter at hand; and (iii) the practical role assigned to Indigenous peoples must be significant and distinctive. The overall aim is to explain that there is at least one important practical advantage of extending and deepening Indigenous inclusion.

1. Introduction

The culmination of this paper will be an *argument from belonging*. This argument has an intermediate conclusion, and a final conclusion. The intermediate conclusion is that a sense of *belonging* not just to the Earth's surface, but to a larger region of space is going to become indispensable if we want to understand the deeper human significance of our expansion into space. The final conclusion is that Indigenous inclusion can and should help to inform the development of such a sense of belonging. For simplicity, "inclusion" will be used as a placeholder for Indigenous participation and engagement with a variety of governmental and non-governmental bodies involved in space activities. As the theme concerns belonging, the argument will also be rather philosophical, and so it concerns the background to policy discussions more than a specified program of action. What is said will be consistent with several policy approaches *just so long as they are shaped by a concern for the relevant kind of inclusion*. While the argument is philosophical, it is nonetheless geared to set out a pragmatic reason for strengthening Indigenous inclusion over the long term. And this pragmatism may help to reinforce a sense that the view set out could make its way into the shaping of policy, or otherwise contribute to answering questions such as "What advantages are there to building Indigenous inclusion into policy?" One answer will be, "We end up with policy that is more just." Another will be, "We end up with policy better geared to the long term." By which, I mean the period of time during which key features of our identity will be reshaped as beings who may belong, and feel at home, not only on the surface of the Earth, but elsewhere also. This *elsewhere* need not be everywhere, or even make us multi-planetary, just so long as it is expansive enough to require a shift in ideas about who we are.

In order to keep the focus upon space, the paper will remain officially neutral about a much wider range of ethical questions concerning Indigenous land rights and territorial sovereignty on the ground, by which I mean only the Earth's surface. This terminology of "ground" is adopted in order to help make sense of a concept of ground bias, i.e., a tendency to ignore the extent to which bodies of knowledge concerning the Earth have been shaped through deliberation about space. "Surface bias" would be another candidate concept [1]. However, the focus upon Indigeneity makes

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the contrast between Sky and ground more appropriate. And one of the advantages of Indigenous perspectives is that they are not typically marked by this kind of bias.

While remaining officially neutral about a range of questions concerning Indigenous sovereignty and land rights, the paper will nonetheless presuppose a broad sympathy with Indigenous predicaments, and with Indigenous group survival in the face of the major civilization-level changes of the present century. Particularly those technological changes which have the potential to be socially disruptive as well as transformative. This background concern for Indigenous predicaments is a concern for justice which helps to motivate the argument, but it will not do any of the heavy lifting within it. The argument will stand or fall on its own pragmatic merits.

2. Indigenous Peoples and space

There is no single Indigenous view about the significance of space programs, but a multiplicity of views, some enthusiastic, others critical. On the critical side, we might think of an apocryphal story from the Apollo era in which a group of prospective astronauts on a training exercise encounter some Navajo in the desert. The astronauts ask if there is a message that they might take to the Moon. They are duly given a slip of paper with some writing that they cannot decipher. What they do not know is that the message, in Navajo/Diné, is “Watch out for these guys, they come to take your land” [2]. The story, originally set out in Jane Young's folklore paper “Pity the Indians of Outer Space” (1987), has multiple levels, but one of them is a concern that space programs will involve *more of the same*. Repetitions of past wrongs in a new context [3], or new sets of wrongs justified by narratives which echo those of the colonial past [4], or even a new mode of colonization with negative implications for vulnerable groups (e.g., migrants and workers) and for the rights of Indigenous peoples as the landscape of launch sites shapeshifts and encroaches [5].

Worries of this sort continue, even in the absence of any belief that a cautionary letter to the people of the Moon or Mars might have recipients who could then be deprived of their land. Nobody is there to read what is written, but this does not disrupt the potential for *more of the same*. Even in the absence of anyone who might be dispossessed, colonialism may be thought of as a structure rather than an event [6], and a structure that operates *everywhere* to the disadvantage of Indigenous peoples. Considered in this way, colonialism may continue and even be extended in the sense that a set of dominant structures remains in place or is reproduced in new places, with modifications and some of the rough edges smoothed away to make it appear as if colonialism is merely historic and not ongoing. Colonial settler theory [7] has promoted this view, and while it has its critics [6], the approach has exercised considerable influence upon colonialism theory over the past decade, impacting heavily upon contemporary Indigenous writing and Indigenous politics in North America [8]. Present within discussions about colonialism and space, but not the only approach in play. A series of four workshops held at MIT in 2021 on “Indigenous and Anticolonial Views on Space” in collaboration with personnel from the Department of Aeronautics and Astronautics stressed a *plurality* of approaches [9]. The colonial settler framework is not deployed here, because of caution about some of the background analogies (particularly analogies with French Algeria, and with the Israel/Palestine conflict), but the larger idea of colonialism as an ongoing structure is accepted as plausible. It also dovetails reasonably well with skeptical approaches towards human expansion into nearby space. Approaches such as Daniel Deudney's in *Dark Skies* (2020) with its analysis of space activities as a continuation and deepening of human conflicts by other means [10]. As a qualification, colonialism as ongoing structure rather than event dovetails well with skeptical approaches, but does not entail any of them. It remains possible to endorse one without the other.

Plausible Indigenous suspicions about space programs also draw support from ongoing terrestrial cases in which Indigenous rights continue to be overridden in the name of technological needs and scientific inquiry. Here, we may think of the ongoing placement of telescopes on the sacred ground of Maunakea in Hawai'i against sustained Indigenous objections [11]. Or the ongoing political tensions in French Guiana, the European Space Agency's near-equatorial launch site used for the Ariane program [12]. These tensions are charted in Peter Redfield's study *Space in the Tropics: From Convicts to Rockets in French Guiana* (2000). A study in which the concept of displacement figures even in times regarded as post-colonial [13]. Whether or not we think in such post-colonial terms, or in terms of colonialism as continuing structure, conflicts are symptomatic of the difficulties involved in getting out from under colonialism's shadow. Here, we might think of the 2017 occupation of the launch pad at Guiana Space Center by Indigenous protestors [14]. Cases of this sort can involve *overriding* of Indigenous concerns, but sometimes they involve a simple *failure to grasp* what those concerns are or their distinctiveness. In the case of the 2017 launch pad occupation, the Indigenous aspect of the protest tended to be lost because it occurred within the context of a mass strike [15]. Coverage and settlement of the dispute reproduced Indigenous marginalization in the face of a set of funding concerns more familiar to government agencies and the French public. Similar difficulties in recognizing, or even making sense of, Indigenous concerns can also be tracked in Michael Sheehan's study of the conflict between the Sami and the Swedish government over the *Esrange* launch site [16], constructed in the 1960s and sitting above the Arctic Circle with what the Swedish Space Corporation describes as “a vast, unpopulated impact and recovery area” [17]. For the Swedish government, the site was ideal in terms of location and because it was wilderness. For the Sami, it was on lands traditionally used for reindeer herding. The initial dispute has been compounded by a tendency to re-read Indigenous concerns in line with dominant and non-Indigenous ecological narratives as a matter of worries about blast protection and fuel discharge. The convenience of which is that once ecological concerns have been addressed, there can be little more to complain about.

If the only problem was *overriding*, then the remedy might still be thought of in terms of greater sensitivity and respect. But given cases of failure to fully understand Indigenous concerns (ecological and more than ecological) as legitimate concerns, inclusion does seem to be called for. Not only in consultation processes, but also in project planning and leadership. But inclusion also carries risks of incorporation, co-opting and the use of client elites. No pathway to Indigenous inclusion in space-related activities is entirely clear of concern. Nor is there any prospect that the emerging narrative about democratizing space will put everything right given that a difficult tension sits at its heart. Smaller nations, and to some extent ESA, push democratization through the admirable goal of greater international inclusion in space activities. But they do so by working with institutional legacies and political inequalities which date back to colonial times or (in terms of a “structure not event” perspective) count as straightforward cases of ongoing colonialism. Hence French Guiana, hence the *Esrange* launch site. The upshot is that the democratization of space can itself become suspect and draw more upon a view of space simply as New Space for industry. Or as a competing ground for techno-nationalist narratives [18] or for some other manner of national and *trans*-national aspirations rather than thinking about space as “place” [19] or as “a cultural landscape” [20], i.e., views which allow a far greater role for concepts of heritage and cultural value.

Some of this calls upon local detail that may not filter through on a global scale, although the predicament of the Sami is well known across the Arctic. But even if such cases, with a direct relation to space, were largely unknown outside of the nations in which they occur, there would still be other drivers for Indigenous suspicions about space programs, across the Arctic and in the Americas. In particular, internationally prominent cases of Indigenous sovereignty are being set aside when the commercial advantages of doing so appear overwhelming. The most recent case from North America has been the construction of an oil supply route through Lakota lands, leading to repeated, extensive, and well-publicized Indigenous protests at Standing Rock in the Dakotas [21,22]. The track record of upholding Indigenous rights in the face of *any* significant counter-imperative (economic, technological, political) is not great. And this may lead us to wonder whether space will be any different or closer to a dark skies option, which we may or may not regard as a continuation of colonialism, but which is likely to at least bear some hallmarks of the latter.

Deondre Smiles, of the Ojibwe, and Chair of the Indigenous Peoples Speciality Group of the American Association of Geographers, has run an argument along these lines, by appealing to "the very real colonial legacies and violence associated with the desire to explore space," in order to suggest that the venture, as presently constituted, "draws from settler colonialism and feeds back into it through the prioritization of 'science' over Indigenous epistemologies" [23]. However, Smiles' approach, while influenced by colonial settler theory, is critical but open to better ways of exploring space and to the societal value of scientific inquiry. Critical openness, and a readiness to align with science and, under the right circumstances, with space programs, also has its drivers. While there are reasons for all of us to be cautious about colonial legacies, there are also strong reasons for all of us (Indigenous and non-Indigenous) to be cautious about legacies of appropriation by hostile opponents of conventional science, and proponents of outright pseudoscience [24–26].

An obvious example is the appropriation of Indigenous storytelling to support spurious claims about alien visitation and human encounters with extraterrestrials. There is at least a century of appropriation, and a trajectory of movement from East to West beginning with Alexander Kazantsev's fantastic idea that the Tunguska Event of 1908, reported by members of the Evenki in Siberia, was really an exploding spaceship [27]. Kazantzev's idea, framed in his fiction but based upon actual commitment to alien contact, migrated to Western Europe and the US as part of the counterculture of the 1960s where it found a large audience through Erik von Däniken's *Chariots of the Gods* (1968).

Since Von Däniken, a small industry geared to appropriation and merger with all manner of tall tales and conspiracy theories (including the bizarre no-Moon-landing theory) has emerged, with ever-increasing oddities (marginalizing Von Däniken's own claims as too tame), and with the unfortunate upshot that appropriation has sometimes created feedback. It has impacted upon at least some Indigenous attempts to rethink the value of their own storytelling traditions. The best-known example is probably Vine Deloria's *Red Earth, White Lies: Native Americans and the Myth of Scientific Fact* (1995) which buys into all manner of ideas from appropriation literature (including Von Däniken), dismisses evolutionary theory, and presents a counter-version of creationism, complete with the survival of dinosaurs into the 19th century [28]. A cautionary tale about the risks of appropriation given the seminal importance of Deloria's earlier political essays distinguishing sovereignty-focused Indigenous dissent from the equality-focused civil rights tradition [29]. An indispensable starting point for attempts to theorize Indigenous dissent in North America by a Lakota from Standing Rock.

Appropriation feedback of this sort seems then to operate at the expense of the integrity of Indigenous storytelling as well as seeking to undermine the authority of conventional science in favor of counter-cultural theories in which evidential standards are much weaker. A point which has not been lost upon the large body of Indigenous scholars who have, over the past three decades, appealed instead to "Native Science" and to "Indigenous Science" in order to travel a quite different path from Deloria, and show that their alignment is *with* science [30]. Yet it is alignment that does not seek to efface the important differences between science in the sense of "Indigenous Science" and science in the conventional sense. An emphasis upon maintaining separation is there in the approach of Gregory Cajete from Santa Clara Pueblo, in his *Native Science: Natural Laws of Interdependence* (2000) [31], and in the approach of Robin Wall Kimmerer of the Potawatomi in *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teaching of Plants* (2013, 2020) [32]. It is also the approach that predominates within Indigenous/Native astronomy [33] across the Americas and among Indigenous scholars who appeal to metaphors of "braiding" and "two-eyed seeing" [34] in order to stress the value of drawing upon both Indigenous knowledge and conventional science, while retaining a sense of their separateness. The value of alignment with conventional science and separation from it is also endorsed in the most impressive studies of Indigenous knowledge by non-Indigenous scholars such as Fikret Berkes' *Sacred Ecology* (2018, 1999), based on his time with the Cree [35]. Alignment has also strengthened in recent years as anti-science narratives (such as the recent Covid-skepticism) have been leveraged for political advantage within mainstream electoral politics [36].

Such leveraging does, however, go back further than the recent pandemic and was one of the drivers for the 2017 *March for Science*, where tens of thousands of Indigenous supporters of science took part in a series of gatherings on Earth Day, centered upon Washington DC and celebrating science in the face of growing concerns about an anti-science political discourse [37]. The Indigenous contribution was focused upon a pro-science "Let Our Indigenous Voices Be Heard" declaration drafted by four prominent indigenous scientists, with Robin Wall Kimmerer taking the lead [38].

A similarly open, and pro-science, attitude can be seen in the Maunakea case, where Indigenous leaders have repeatedly emphasized respect for science at the same time as arguing that they should not be subject to someone else's *imposed* set of geographical restrictions on what they view as sacred, or what counts as cultural heritage. To say, for example, that grave sites can be sacred and cultural heritage, but the mountain that they are on is not sacred, would seem to go beyond anything that might be scientifically underpinned. At the heart of the dispute over additional telescope placement is an argument about power structures, priorities, and whose conception of the sacred and of heritage should matter most, rather than any manner of opposition to science *per se*. It would be odd to suggest Indigenous Hawaiian hostility to the latter, given a history acknowledged through outreach work by Hawaiian observatories, and registered in the IAU's naming of the interstellar object 1I/2017 U1, "'Oumuamua." A term which translates as something like "a messenger from afar arriving first" in Hawaiian [39]. Partly chosen as a result of the role of Haleakalā Observatory in the object's discovery, but it is difficult to read the term this way without thinking that an oblique reference to Galileo Galilei's *Starry Messenger*/*Sidereus Nuncius* (1610) may be built into the translation (and possibly the original). This would emphasize the idea of two complementary ways of looking, as well as hopes for mutual respect across thought systems. A theme that figures prominently in the Maunakea protests. Sara Kahanamoku, a Native Hawaiian and paleoecologist who has been involved in the opposition to further telescope placement envisions "a future where the

practice of science is truly ethical: where human rights, including the rights of Indigenous people to self-determination, are upheld through the practice of science. I envision a future where scientists value human relationships in the same way that we value critical thinking and curiosity" [40]. Framed in this way, the dispute shows the limitations of an oversimplified contrast between Indigenous practices of valuing and the values which are integral to good scientific practice. A more plausible contrast might be made between differing conceptions of good scientific practice. More plausible, because considerations of cultural heritage tend towards the protection of the night Sky from light pollution [41, 42]. The most well-known recent case being the mass deployment of small satellites as part of SpaceX's Starlink constellation, which turned out to be far more intrusive than anticipated. The IAU's verdict on the latter was that good intentions were not enough in the face of serious threats to ground based astronomy and the need to safeguard the radio sky from interference [43]. Given the right circumstances, protection of cultural heritage on the ground and in the Sky can align well with concerns of this sort about the deployment of potentially intrusive technologies without adequate consideration of impact.

Smiles' critical but open approach to human activity in space presses much the same point as Kahanamoku and even, up to a point, the IAU. It is not ultimately a rejection of such activities, but a note of warranted caution about how they are carried out, and the risks of repeating past mistakes as a result of failures to come to terms with ongoing structural legacies. Such legacies can reinforce an overly limited view of good scientific practice. In both the Maunakea case, and in Smiles' provisional theorization of Indigeneity and space, there is also the shared recognition that "Indigenous people have always been engaged with the worlds beyond the Earth" [23]. While often treated as ecologies in order to emphasize their value, Indigenous cosmologies have always been *more than ecologies*, oriented to the Sky as well as the ground [44]. This is a source of their strength, and of their vulnerability to appropriation. In recent times, Indigenous storytelling has also extended to what Grace Dillon of the Anishinaabe calls "Indigenous futurisms" in which traditional Indigenous storytelling is fused with science fiction in unique, distinctive, ways [45]. One of the best-known instances is "Men on the Moon" a revised version of a contemporaneous account of the 1969 Moon landing by Simon Ortiz (Acoma Pueblo) in which we see complex generational differences in attitudes towards activities in space, and puzzlement about its ultimate goals [44,45]. Indigenous futurisms, with a similarly complex attitude, have moved into art and film with the 15 min short, *The 6*th *World,* in which a Navajo astronaut has a revelatory dream on the night before setting out to begin the colonization of Mars [46,47].

Beyond concerns about cultural appropriation, there is an even larger rationale for Indigenous agents to adopt a combination of critical and open attitudes along the lines of Smiles, Kahanamoku, and (in different ways) Indigenous futurisms. A rationale focused upon survival in difficult times. To be outside of the major changes facing humanity, or to be seen as having little to contribute to them, is figuratively *to be nowhe*re. It is, in a terminology borrowed from Hannah Arendt [48], to be *superfluous* in relation to the defining changes of our times. Cultures end when forced to subsist outside of a changed order of things as the outside becomes a vanishingly small place to be. Indigenous group survival may well depend upon inclusion within key processes of technological change, beginning with inclusion in Earth monitoring systems, and in the integration of satellite data into ground-based tracking of animal movement and migration, and into farming and woodland stewardship on the third of the Earth's surface currently used and managed by Indigenous peoples [49]. Such inclusion has a broader value given the strategic importance of Indigenous concentration on lands which account for around 80% of the Earth's biodiversity [50]. However, this entire approach calls upon a level of pragmatism among Indigenous peoples themselves in the form of a readiness to consider the possibility that inclusion and cooperation can involve something other than modified continuations of colonialism.

3. A pragmatic Approach

So far, the idea of a pragmatic approach has been introduced, but also left a little vague. To give a clearer indication of what is meant, three pragmatic constraints will be introduced and the beginnings of pathways to future Indigenous influence upon space policy will also be shown. Without pathways to influence, talk about a pragmatic argument for inclusion will be divorced from inconvenient realities. And without some constraints, talk about a pragmatic approach may be mostly presentation and little substance.

(i) *Three Constraints*

The first of the three constraints is that the argument should be geared to future policy discussions rather than counterculture of any sort. (Even the kinds that we might admire.) The argument may appeal to Indigenous knowledge, and even to such knowledge as a special and separate kind of Indigenous Science or Native Science [31,32,35]. But it may not do so in a way that undermines the importance of science in the conventional sense, or the special role that such (conventional) science plays within policy formation over matters such as climate change, epidemic response, and governance in the face of technological change. Let us call this *gearing of approach*.

The second constraint is that some reason must be given for regarding Indigenous knowledge as at all relevant to the matter in hand, i.e., belonging to a larger region of space. This reason must also not violate the first constraint. Sense must be made of the cosmological dimension of Indigeneity or Indigenous knowledge in terms that do not conflict with conventional science or lead us back into countercultural critique. As the focus is upon the more cosmological side of matters, let us call this the *more than ecologies* requirement.

Finally, the role assigned to Indigenous peoples and Indigenous knowledge should be both distinctive and significant. Any exclusively technical role is unlikely to meet this requirement, given that such roles can generally be transferred across agents with little concern for cultural background. A non-transferrable role with some deeper human significance will meet this constraint, even if it requires a less obvious level of justification and appeal to some philosophical terminology. Let us call this *significance of role*.

These three constraints, or adequacy conditions, are set out in no particular order of importance. Failure to meet any one of them will be taken as argument failure, from a pragmatic point of view. An argument that fails to meet one or more conditions might still be interesting, but it would not be *pragmatic* in the sense used here. An argument could also meet all three conditions but fail in some other way. For example, the understanding of Indigeneity that it brings into play could be insufficiently nuanced or lacking in an appreciation that there are very different groups of Indigenous peoples rather than one single homogeneous block of Indigenous people. Or an argument could meet the three conditions but simply fail to accommodate the point that "Indigeneity" is not actually an Indigenous concept, but one which has come from outside and only works *up to a point*. To limit such risks, the concept of "Indigeneity" will be used only as a placeholder for a more complex story about some 370 to upwards of 500 million humans whose range of affiliations and traditions is so diverse that the UN resists endorsement of any single definition [51]. I will follow this same

precautionary practice rather than slipping from open criteria to the closure of a limited definition [52,53]. The peoples discussed will also be non-controversial instances of Indigenous peoples or, in the Chinese case, *shaoshu minzu* i.e., national minorities such as the Nuosu who are non-controversially bearers of what is sometimes called traditional knowledge. For convenience, I will refer to Indigenous inclusion but what I have in mind covers both Indigenous groups and *shaoshu minzu*.

The practicality of strengthening a relation with some space program will also be clearer if the examples used draw only upon peoples who live within, or close to, the territories of the three main space powers, i.e., the US, China, and Russia. Finally, as it is not my intention to present a survey but an argument, particular attention will be given to the Navajo/Diné as a special exemplar, chosen because of the longstanding and multiple-renegotiated character of the Navajo-NASA relationship. It is the most sustained example of relationship building between any Indigenous people and any space agency.

(ii) *Pathways To Influence*

Conveniently, support for at least some level of Indigenous inclusion appears to be widespread and institutional. This presents us with the rudimentary beginnings of pathways through which inclusion could, at some point, lead to influence of other sorts. Influence significant enough, and realizable enough, to help meet the last of the three adequacy conditions above, i.e., *significance of role*. As matters currently stand, recognition of Indigenous and minority entitlements is built into the policy of all the major space agencies. NASA in particular has been clear about the need for inclusion and change. For example, its 2021 consultation exercise, *Mission Equality*, was announced as "a comprehensive effort to assess expansion and modification of agency programs, procurements, grants, and policies, and examine what potential barriers and challenges exist for communities that are historically underrepresented and underserved" [54]. And while there can be large gaps between consultation and implementation, and between policy and practice, there have been clear moves to enhance Indigenous participation inside the US and elsewhere. For example, "Earth Observations for Indigenous-led Land Management" (EO4IM), is a partnership with the Achuar of Ecuador and the Awajún in Peru, geared to recognizing the strategic location of Indigenous peoples on lands where biodiversity is high but in need of protection [55]. An example which simultaneously shows institutional commitment to engagement, and (because it extends beyond US borders) the potential of such engagement to feed fears about continuities of colonial structure.

Within the US, NASA has a particularly strong relationship with the Navajo/Diné, acknowledged in February 2021 when the Perseverance Rover landed safely in Jezro Crater, an area of Mars named after a (terrestrial) canyon in Navajo territory [56]. The first prominent feature to be examined was then named "Máas," a Navajo borrow word from English on a list of 50 Navajo words for NASA use, put together by Jonathan Nez, the president of the Navajo nation. "We hope that having our language used in the Perseverance mission will inspire more of our young Navajo people to understand the importance and the significance of learning our language. Our words were used to help win World War II, and now we are helping to navigate and learn more about the planet Mars" [57]. Aaron Yazzie, a Navajo engineer on the Perseverance team based out of the NASA Jet Propulsion Laboratory, also helps to shape a process which could easily go wrong. An example of multi-level inclusion.

Naming is itself a multiple-level practice. We name people, companions, and places, but number qualitatively indistinguishable things. The names that we use can also say something about how we value and relate to what is named. In the case of the Perseverance team, it is tempting to say that the use of Navajo words on Mars involves small acts of rebalancing. This is also in keeping with broader norms for celestial bodies. Schools on Earth are often called after Christian soldiers, saints and martyrs, but lunar features are not. A small but rather nicely formed lunar impact crater in the Mare Serenitatis is named after the German astronomer Robert Luther, but none is named after Martin Luther [58]. Colonizer and explorer names are another, more complex, matter. There is a Columbus crater on Mars, in the Terra Serenum, just as there are Columbus features everywhere on Earth. And there is a Vasco de Gama crater, as well as a crater named after Vasco de Nunez de Balboa, but none named after Francisco Pizzaro. Caution about such matters is typical of NASA's more recent practices. If they were named/christened today, it is unlikely that the lunar command module for Apollo 11, or the ill-fated Space Shuttle OV-102 would have been called Columbia, even if it was in honor of the first US ship to circumnavigate the globe. Contemporary naming is a balancing act in which avoidance plays an important role. The complex collection of satellites that form part of the Mission to Planet Earth, and from which we draw down so much of our data about climate change, carries the acronym of EOS (Earth Observation System), chosen as an allusion to the Greek goddess of the dawn [59]. Classical naming can still generate controversy about Western bias, but it is a step removed from and a way to avoid direct appeals to legacies of colonial settlement. Institutional sensitivities to the latter, by NASA and other agencies, help to convey a sense that what is sometimes called "the democratization of space" [60] has aspects beyond the commercial, even if it also (and conspicuously) involves a move from a few commercial players to many [61,62]. Multiplicity and diversity, having many and different players seems to be valued.

The use of guided Navajo/Diné naming also suggests ways in which the Navajo-NASA relationship can operate in both directions. In terms of Sky to ground cooperation, the Applied Sciences team within NASA's Earth Science Division works with indigenous water management personnel who use satellite technology to help track water supplies in arid areas [63,64]. Training is conducted on Indigenous lands, in deference to the bad history of removal for native school education. Admittedly, the idea of NASA supplying environmental data about water sources, and the Navajo nation being the beneficiary is a pared back and one-directional account of how Earth monitoring actually works. In projects of this sort, there is always movement in both directions. However, the Mars naming adds a clear example of information going the other way, from ground to Sky.

As we would expect, there are limitations to relationships of this sort. And structures of exploration and cooperation do carry legacies irrespective of whether or not we think about them in the terms of settler colonialism or in terms of institutional inertia. We may also anticipate difficulties reproducing anything similar between Roscosmos and Indigenous peoples of the Arctic such as the Eveni and the Evenki, or peoples such as the Tubalars, in the areas near the Russian launch site at Baikonur. Or between China's CNSA and the *shaoshu minzu* such as the Nuosu, although in both the Chinese and Russian cases there have been clear attempts at inclusion, framed in terms of minority participation within larger national identities. In both China and Russia there are also significant economic rationales for improving the flow of information from Sky to ground: to help shape reforestation in Southwest China where such efforts have been noticeably less successful than they have been closer to Beijing, and where there are large *shaoshu minzu* populations on the ground [65]. Similarly, in the Russian case, such inclusion could help to deal with the multiple problems

of monitoring high latitude Siberian woodland (designated Evenki and Eveni territory) which remain comparatively inaccessible in spite of economic and infrastructure activities across the Russian Arctic [66]. Nonetheless, whatever the difficulties of reproducing a direct counterpart in Asia or Eurasia, the Navajo-NASA relation shows the potential for modest pathways to future influence to emerge, given some level of persistence and a clear prospect of mutual advantage [67].

Turning such pathways into deeper levels of influence *anywhere* may ultimately depend upon fuller inclusion within program design and project leadership. And it may depend upon influence within the political structures which help to shape space agency goals. And this is only at the level of official government agencies and bodies. Given the ongoing interconnection of state and commercial entities, it could also be of considerable benefit if Indigenous agents were present on both sides, as well as within NGOs and also within the protest movements which we may now expect to target *particular* space activities in a less sporadic manner than in the past. The advantage of a multi-niche approach is one of the lessons of environmental movements: a one-track approach is far less likely to make headway than an approach in which all available niches are filled [68]. Within policy formation itself, a familiar range of routine options is available such as quotas and stricter requirements for consent in cases such as Maunakea, with all of the familiar difficulties that such measures involve. However, none of these options are likely to matter in the absence of two things. The first is that Indigenous agents are not co-opted in ways that pressure them to reject their own traditions. Without making too much of the terminology, we may think of this as an "authenticity" requirement. The second is ongoing multi-level dialogue through which the differences between Indigenous concerns and concerns that have shaped responses to other kinds of injustice may come to light. In the absence of a sufficiently rich dialogue, there will be a danger of the sort that can be seen in governmental misreading of Sami concerns [16]. However, this is not a point about the obtuseness of governments. It applies as much to dissent as it does to governmental bodies and space agencies. There is always a risk that dominant traditions of non-Indigenous dissent will appropriate and subsume Indigenous dissent at the expense of any fuller grasp of its distinctiveness. (A point that Vine Deloria appreciated in his early political writings, and a further reason for at least a degree of caution about colonial settler theory.)

4. The argument from belonging

Let us now consider the philosophically framed pragmatic rationale for extending and deepening inclusion and pathways to inclusion over time. Philosophically framed in the sense that it involves concepts such as belonging, more familiar from anthropology, or from the writings of philosophers such as Heidegger [69] and Charles Taylor [70], and in the sense that it uses a thought experiment which owes something to a novel *Andromeda Nebula* (1957) by the Cosmist author and paleontologist Ivan Yefremov [71]. Let us imagine a group of humans who have, five centuries from now, discovered a deep underground cave containing a collection of preserved artifacts from the 1950s. A time vault occupying a large, but still limited, space. Inside, they find cars, books, and a variety of electronic equipment. There are photographic images of long-forgotten political figures and of rock art from Lascaux and Santander, the originals of which have long since eroded; an autographed publicity picture of a man called Morey Amsterdam; a framed baseball jersey with the number 3 on it. In short, the cultural wealth and detritus of people who belonged to a human generation half a millennium earlier. We can well imagine that those who descend into the cave would be delighted with some things, but disappointed with others. Why was so much space wasted on trivia? Why are there so few of the important things that might easily have been included, but were left out?

In the eyes of future generations, the legacy of our early projects in space may look a little like this. A mixture of the worthwhile and the curious, the fashionable and the deep. In this respect, human expansion into nearby space exemplifies a more general problem facing multi-generational projects of any sort: what is accomplished will depend largely upon those who come later. We ourselves will see very little, only the beginning. The vulnerabilities of such projects can also increase with the dynamism of the societies concerned. Major economic and technological changes can rapidly undermine plans for the future. We already expect the world of the grandchildren of those born today to look significantly different from the world of today. We do not have the consolation of Ecclesiastes 1.9, the belief that there is nothing new under the Sun. This vulnerability to later events, our limited horizon, and our lack of control over future actions need not make our hopes and plans unimportant. But recognition of such vulnerability serves as a reminder that the *meaningfulness* of what we do now will depend upon the place that our actions occupy within a much larger and mostly unknown sequence of events.

Admittedly, there may be some advantageous structuring inertia, a founder effect that may help to shape the ongoing trajectory of at least some multi-generational projects [72]. Such an effect might allow agents situated at the start of space expansion (i.e., ourselves) a disproportionate role in constraining future options. Yet, in the absence of an understanding of what runs deep within our human concern with space, our appreciation of how a founder effect might actually feed through is itself liable to be skewed. If we want to optimize the stability of our goals, or at least their chances of having some kind of legacy with clear ties to our hopes and dreams, then a grasp of what runs deep within our human concern with space will be a major advantage. What is at stake here may also be thought of as a kind of *sustainability*. I am also not the first person to point to this problem. J. G. Ballard made much the same point in his series of Cape stories from the 1960s onwards: depictions of a fictional landscape of Apollo launch sites, overrun by jungle following a failure of continuity, and a falling off in concern with space [73]. Ballard's point was not that we could indefinitely postpone a space age, but that the Cold War drivers for the race into space were not leading to sustainable programs. Beyond initial enthusiasm, the project would lack stability. Similarly, the thought experiment draws from the closing section of a Yefremov text which was written at the height of belief in the Soviet system, a belief that the author shared enthusiastically, but abandoned in a sequel so critical of the authorities that it was withdrawn from libraries. Some commitments abide, others do not.

None of this has to lead us into the murky territory of positing any historically fixed essential core of human concerns in a search for something that we may rely upon. Even if we reject the idea of a single essentialist human nature, or of a single abiding human attitude towards space, some things will still be difficult to set aside. Even under the impact of shifts in political institutions and ideologies. We may think of these more durable concerns as *matters that run deep within human lives*, but not necessarily as universal constants. On the plus side, we are never entirely in the dark about good and bad candidates for what tends to last. The drawings of rock art in the imagined cave vault are better candidates than the autographed picture of a television celebrity. By contrast, our current enthusiasm for the commercialization of space has a standing that is less clear. And the same may be said about the democratization of space in any form. We do not know where it will end up, whether it will seem like a utopian 21st century project or the beginnings of a beautiful friendship.

Discussions about the rationales for expanding our human presence in space have already identified a number of plausible candidates for what tends to survive across time. One candidate is the idea of an innate human *urge to explore*. An idea with supporters ranging from the more speculative Robert Zubrin [74] to the scholarly Jacques Arnould [75]. Although it has been qualified by Milligan [76], who argues that it would have to be a species-level trait, and not an individual psychological urge, and by Schwartz [77], who argues that there is no known genetic or biological basis for the urge in question. It is also difficult to see how a never-ending urge to explore would fit with the recognition that space expansion may ultimately be limited to the establishing of a direct human presence only in some portion of the Solar System and not beyond. At the very least, a conception of such an innate urge needs to be tempered by the recognition of other, and perhaps better, candidates for *matters that run deep within human lives*. The most obvious of these is, again, our concern with origins and with belonging. Concepts which are intertwined. If there is a recurring and general human urge to explore, it is unlikely to be an urge to *belong* nowhere, or (in a phrase from Yefremov's more disillusioned text) to live as *vagrants of the universe* [78]. Any urge to explore might have to be only the other side of a desire to belong. A search for belonging rather than an evasion of it. The goal of any human settlement elsewhere could then be thought of as a matter of becoming Indigenous, rather than a conquest of place.

We cannot, of course, become Indigenous in the way that is simply a repetition of terrestrial Indigeneity, the very idea of which is contrastive: some agents are Indigenous, others are not. But in thoughts of this sort, about *becoming beings who are at home*, the importance of belonging does seem to be in play. Thoughts of this sort also point towards the value of Indigenous knowledge and the reasons why we think of it as deep, i.e., its recurring concern for having a place in the world, and making sense of that place. We can see this not only in Traditional Ecological Knowledge about terrestrial environments, but also in more or less any Indigenous cosmology, historic or ongoing. Although, it may be more obvious in some cases than in others. Thinking again about China's Nuosu, in the *Book of Origins*, a text still routinely recited at social and ceremonial events, the hero Zhyge Alu shoots down six suns and seven moons in order to make an overheated world livable [79,80]. Through this action, the Earth becomes a place where the twelve snow tribes originating in the skies, could become ancestors, six becoming ancestors of plants, and six becoming our ancestors and the ancestors of other animals. Or we might think about the Iroquois creation story. A woman falls from the skies, from the Pleiades (a location of persistent Indigenous interest), and ends up on Turtle Island, living on the earth brought by animals from the floor of the ocean (itself, a great being, prior to Earth as we now know it) [32]. These tales carry a sense of evolution as co-evolution, humans as beings who transform their environment to make it livable, and of belonging as an achievement, as something that may be brought about at the expense of various kinds of risk.

There are, of course, many tales of this sort. Indigenous cosmologies vary greatly, but part of what makes them cosmologies is their concern with a belonging that is not exclusively Earthly. The *more than ecologies* requirement is put in place for precisely this reason. Within Indigenous origin storytelling, belonging is typically Earthly, but also more than Earthly. We do not, of course, need to embrace the cosmologies themselves, or to romanticize Indigenous agents in order to recognize at least a *type similarity* with what we are currently moving towards: *if our current narratives about space expansion are broadly correct, the view of things that our moral community will need will also be more than ecological in the sense of being more than Earthly.* We can, of course, talk about super-ecologies, and extend the latter concept, but it will be an extension beyond what is ordinarily in place when ecosystems are spoken of.

This is the core of the *argument from belonging*: Indigenous peoples may have a significant and distinctive role to play in space expansion because such expansion also generates a need to enlarge our sense of belonging beyond the ecological. Less formally, we need not begin from scratch if we want to understand *what it is like* to see our world in an enlarged and more than Earthly way. We already have something to go on. However, the relevant knowledge can hardly be separated out, or otherwise appropriated, from those Indigenous agents who are knowledge bearers. There are, of course, no guarantees, and the vulnerability of our projects to the actions and indifference of future agents is ineradicable. Yet any enhancement in our understanding of *what runs deep in human attitudes towards space* is likely to impact positively upon the sustainability of at least some of the multi-generational projects that we initiate. In light of such knowledge, the projects that we initiate may have a better fit with the changed attitudes of future agents.

5. Conclusion: Overcoming ground bias

Another way to put this rather philosophical argument would be to return to a concept introduced at the start, the concept of ground bias. Ground bias is a matter of failing to fully acknowledge a larger than Earthly context and, when required, it involves the rewriting of insights so that they appear to have emerged out of reflection upon the Earth alone, and often upon only its outer surface [1,81]. Indigenous knowledge, storytelling, and cosmologies do not tend to suffer from this bias, but a good deal of our contemporary ways of thinking, including discussions about the value of space exploration, are shaped by it. By this, I mean that when we ask questions such as *'Why should we do x in space when we need to sort out problems here on Earth?'* there is generally a background presupposition that it makes sense to tackle terrestrial problems with no reference to anything else. There is often a presupposition that such an option exists, is viable and a good deal more direct. Tempting though such a thought is, it depends upon rewriting how we have arrived at our best understandings of the Earth.

Here, I am not suggesting that ground bias is a matter of irrationality. Rather, it is simply a kind of oversight, a failure to see or recognize the ongoing importance of space that ordinary rational agents have tended to develop under the conditions which have prevailed in parts of the world over the past couple of centuries. Figuratively, we might compare it to the disappearance of the night sky in highly illuminated cities where the most advanced forms of technology are also to be found. The problem does not concern all agents or all times. Kepler and Tycho Brahe clearly suffered from no such bias, but theirs was a world in which navigation required agents to look up, regularly. What was once routine has now become exceptional, restricted to astronomers, enthusiasts, and specialized groups of humans. Yet over this same period of time our more widely disseminated understandings of the Earth have continued to draw upon space, but without clear acknowledgment. Here, we may think about the identification of the greenhouse effect by James Hanson at NASA by analogy with runaway warming processes on Venus [59]. Or, as a combination of science and cosmopolitical theory, we may think of the Gaia hypothesis that life on Earth is analogous to a single large biological cybernetic system [82]. A productive analogy that emerged out of James Lovelock's life-detection work at NASA in the 1960s, comparing our Earth's atmosphere with that of Mars [83]. Neither of these theories were the result of looking only and directly at the Earth without placing it

within some larger context. On a more historic scale, we might reflect upon the way in which Galileo's reworked concept of "systemi" has over the past century, migrated into our understanding of eco*systems*, and environmental *systems* [1]. We routinely call upon the Galilean concept but with little or no acknowledgment of how we arrived at such a way of speaking and thinking.

Whatever their other limitations, Indigenous knowledge, cosmologies, and storytelling do not suffer from the same problem to the same degree. They may be short on formalism and quantification, but they are strong on contextualizing knowledge about the Earth and doing so within a larger context of belonging. This does not mean that you, or I, or everyone we know should (or even could) embrace the cosmology of the Lakota, or the Nuosu, or the Eveni or the Evenki. It does mean that we do not have to entirely reinvent the wheel as human identities are reshaped under the influence of space expansion. There are valuable exemplars of ways of seeing which avoid ground bias and involve a more than Earthly sense of who we are. These exemplars are ready to hand, or at least accessible. Yet, of course, significant differences remain. Indigenous ways of belonging emerged in contexts limited by the absence of any actual possibility of being physically present anywhere other than on the Earth's surface. That is an important difference. While there may be a *type similarity* between Indigenous cosmologies and ways of seeing appropriate for an age of space expansion, the latter will also involve new and quite different ways of belonging. Indeed, Indigenous ways of belonging are also likely to alter with the prospect of actual physical presence elsewhere. The physicality of being elsewhere changes things. Even the possibility of being elsewhere may do so. Contrasts as well as continuities with Indigenous belonging abound.

The above case made for extending inclusion, by appeal to belonging and its importance as something that runs deep, has also been of a rather philosophical sort. Yet, it does meet the three adequacy conditions. In this sense, it does qualify as pragmatic. The *gearing of approach* to policy discussions rather than to counterculture has been upheld. The familiar boundary between Indigenous knowledge (alternatively: Indigenous Science) and conventional science has not collapsed. A treatment of Indigenous cosmologies as both instructive and *more than ecologies* has also been pivotal to the point that humans are going to need an attitude with a type similarity to Indigenous cosmologies. Finally, the requirement for *significance of role* has been satisfied. The reason for shifting discussion into a more philosophical register is precisely that belonging is significant at a civilization-shaping level. All three minimal adequacy conditions have been met. In spite of philosophical formulation, the argument is pragmatic in the relevant sense.

None of this entails that current or future activities in space will be able to reverse the injustices of the past. Nor does it give us simple answers to complex questions about how to mitigate bad legacies in particular cases such as Maunakea or in French Guiana. The *argument from belonging* may give us hints, clues, and reminders about these things, but it is not directly focused upon them and carries no direct implications about the details of conflict resolution. The argument supports only a broader approach to inclusion, and it is consistent with acknowledgment of all the usual problems associated with building minority perspectives into the policy formation processes of liberal democracies and related systems. Setting aside the importance of having Indigenous personnel in place at multiple levels of space programs, and at key levels of policy formation, Indigenous perspectives may also, and often, remain only among the precursors to policy rather than among the more immediate and pressing rationales of governance. None of this changes. Yet, the argument does give a plausible long-term reason for including Indigenous knowledge and Indigenous agents *within* space expansion, while remaining pragmatic all the way up, and all the way down.

CRediT

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References

[1] V. Olson, Into the Extreme: US Environmental Systems and Politics beyond Earth, University of Minnesota Press, Minneapolis, 2018.
[2] J.M. Young, 'Pity the Indians of outer space': Native American views of the space program, West. Folklore 46 (4) (1987) 272–273.
[3] L. Billings, Should humans colonize other planets? No, Theol. Sci. 15 (3) (2017) 321–321.
[4] H. Neilson, E.E. Ćircović, Indigenous Rights, Peoples, and Space Exploration, submitted to the Canadian Space Agency call Consulting Canadians on a Framework for Future Space Exploration Activities, 2021. https://arxiv.org/pdf/2104.07118.pdf. (Accessed 18 May 2022).
[5] Audra Mitchell, Outer space, in: P.D. Williams, M. McDonald (Eds.), Security Studies: an Introduction, Routledge, London and New York, 2018, pp. 569–582.
[6] P. Wolfe, Settler colonialism and the elimination of the native, J. Genocide Res. 8 (4) (2006) 387–409.
[7] L. Veracini, 'Settler colonialism': career of a concept, J. Imper. Commonwealth Hist. 41 (2) (2013) 313–333.
[8] N. Shoemaker, A Typology of Colonialism, 2015. https://www.historians.org/publications-and-directories/perspectives-on-history/october-2015/a-typology-of-colonialism.
[9] MIT Media Lab, Indigenous & Anticolonial Views of Human Activity in Space: Workshop, 2021. https://www.media.mit.edu/events/indigenous-anticolonial-views-of-human-activity-in-space-1/ [Accessed 18 May 2022].
[10] D. Deudney, Dark Skies: Expansion, Planetary Politics and the Ends of Humanity, Oxford University Press, Oxford, 2020.
[11] D. Clery, New front emerges in battle to build giant telescope in Hawaii, Science 367 (6475) (2020) 236–237.
[12] ESA, Europe's Spaceport in French Guiana, 2020. https://www.esa.int/ESA_Multimedia/Videos/2019/12/Europe_s_Spaceport_in_French_Guiana [Accessed 17th May 2022].
[13] P. Redfield, Space in the Tropics: from Convicts to Rockets in French Guiana, University of California Press, Berkeley, 2000.
[14] H. Duranni, Is Spaceflight Colonialism? the Nation, July 19th 2019, 2017. https://www.thenation.com/article/world/apollo-space-lunar-rockets-colonialism/. (Accessed 17 May 2022).
[15] France 24, 2017. France Clears Guiana Aid Package as Protesters End Space Centre Occupation, https://www.france24.com/en/20170405-french-guiana-aid-package-protest-space-centre-kourou [Accessed 18th May 2022].
[16] Michael Sheehan, Outer space and indigenous security: Sweden's ESRANGE launch site and the human security of the Sami, in: K. Hossain, J.M.R. Martin,

A. Petrétei (Eds.), Human and Societal Security in the Circumpolar Arctic, Brill, Leiden, 2018, pp. 122–140.
[17] Swedish Space Corporation, Esrange Space Centre, 2018. https://sscspace.com/ssc-worldwide/esrange-space-center/ [Accessed 18th May 2022].
[18] D. Stroikos, China, India, and the social construction of technology in international society: the English school meets science and technology studies, Rev. Int. Stud. 46 (5) (2020) 713–731.
[19] L. Messeri, Placing Outer Space: an Earthly Enthography of Other Worlds, Duke University Press, Durham NC, 2016.
[20] A. Gorman, The cultural landscape of space, in: A.G. Darrin, B.L. O'Leary (Eds.), The Handbook of Space Engineering, Archaeology, and Heritage, CRC Press, Boca Raton, 2009, pp. 335–346.
[21] D. Archambault II, The standing rock protests and the struggle for tribal sovereignty: an interview with David Archambault II, J. Int. Aff. 73 (2) (2020) 233–238.
[22] K.P. Whyte, The Dakota access pipeline, environmental injustice, and US settler colonialism, in: Char Miller and Jeff Crane (eds.) the Nature of Hope: Grassroots Organizing, Environmental Justice, and Political Change, University Press of Colorado, Boulder, 2018, pp. 320–338.
[23] D. Smiles, The Settler Logics of (Outer) Space, Society + Space, 2020. https://www.societyandspace.org/articles/the-settler-logics-of-outer-space [Accessed 8th July 2021].
[24] M. Brown, Cultural records in question: information and its moral dilemmas, Cultural Resource Management 21 (6) (1998) 18–20.
[25] L. Aldred, Plastic shamans and astroturf sun dances: new age commercialization of native American spirituality, Am. Indian Q. 24 (3) (2000) 329–352.
[26] B. Sheets, Papers of plastic: the difficulty in protecting native spiritual identity, Lewis & Clark Law Review 17 (2) (2013) 591–635.
[27] A. Kazantsev, Explosion, in: Yvonne Howell (Ed.), Red Star Tales: A Century of Russian and Soviet Science Fiction, Russian Life Books, Montpellier, 2015, pp. 224–249.
[28] V. Deloria, Red Earth, White Lies: Native Americans and the Myth of Scientific Fact, Fulcrum, Colorado, 1997.
[29] V. Deloria, Custer Died for Your Sins, University of Oklahoma Press, Norman, 1988.
[30] Worldwide Indigenous Science Network, 2022. History, https://wisn.org/about/history/ [Accessed 17th May 2022].
[31] G. Cajete, Native Science: Natural Laws of Interdependence, Clear Light Publishers, Santa Fe, 2000.
[32] R.W. Kimmerer, Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants, Penguin, London, 2020.
[33] Native Skywatchers, Two Eyed Seeing: Ojibwe Astronomy & NASA Moon to Mars, 2020. https://nativeskywatchers.com/two-eyed-nasa-ojibwe.html [Accessed 17th May 2022].
[34] C. Bartlett, M. Marshall, A. Marshall, Two-Eyed Seeing and other lessons learned within a co-learning journey of bringing together indigenous and mainstream knowledges and ways of knowing, Journal of Environmental Studies and Sciences 2 (2012) 331–340.
[35] F. Berkes, Sacred Ecology, Routledge, London & New York, 2018.
[36] P. Hotez, COVID vaccines: time to confront anti-vax aggression, Nature 592 (2021) 661. https://www.nature.com/articles/d41586-021-01084-x [Accessed 17th May 2022].
[37] B. Kahn, Scientists Are Planning the Next Big Washington March, Scientific American January 26th, 2017, 2017. https://www.scientificamerican.com/article/scientists-are-planning-the-next-big-washington-march/. (Accessed 12 October 2021).
[38] R. Kimmerer, R. LaPier, M. Nelson, K. Whyte, We Endorse and Support the March for Science, 2017. https://www.esf.edu/indigenous-science-letter/Indigenous_Science_Declaration.pdf [Accessed 17th May 2022].
[39] NASA, 'Oumuamua, 2019. https://solarsystem.nasa.gov/asteroids-comets-and-meteors/comets/oumuamua/in-depth/ [Accessed 17th May 2022].
[40] S.S. Kahanamoku, The Fight for Mauna Kea and the Future of Science, 2019. https://massivesci.com/notes/mauna-kea-thirty-meter-telescope-colonialism-astronomy/ [Accessed 17th May 2022].
[41] A. Venkatesan, J. Lowenthal, P. Prem, M. Vidaurri, The impact of satellite constellations on space as an ancestral global commons, Nat. Astron. 4 (2020) 1043–1048.
[42] D.W. Hamacher, K. De Napoli, B. Mott, Whitening the Sky: Light Pollution as a Form of Cultural Genocide, 2019. https://arxiv.org/pdf/2001.11527.pdf [Accessed 18th May 2022].
[43] IAU, IAU Statement on Satellite Constellations, 2019. https://www.iau.org/news/announcements/detail/ann19035/ [Accessed 18th May 2022].
[44] J. Adamson, S. Monani, Cosmovisions, ecocriticism, and indigenous studies, in: J. Adamson, S. Monani (Eds.), Ecocriticism and Indigenous Studies: Conversations from Earth to Cosmos, Routledge, London, 2016, pp. 1–19.
[45] G. Dillon (Ed.), Walking the Clouds: an Anthology of Indigenous Science Fiction, University of Arizona Press, Tucson Arizona, 2012.
[46] Futurestates, The 6th World, 2011. https://www.youtube.com/watch?v=7f4Jm0y_iLk [Accessed 17th May 2022].
[47] W. Lempert, Navajos on Mars, 2015. https://medium.com/space-anthropology/navajos-on-mars-4c336175d945 [Accessed 17th May 2022].
[48] H. Arendt, K. Jaspers, Hannah Arendt/Karl Jaspers: Correspondence 1926-1969, in: Lotte Kohler and Hans Saner, Trans. Robert and Rita Kimber, Harcourt, Brace, New York, 1992.
[49] B. Vander Velde, Tradition Meets Tech: Can Satellite Data Help Indigenous Peoples Protect Their Lands?", 2017. https://www.conservation.org/blog/tradition-meets-tech-can-satellite-data-help-indigenous-peoples-protect-their-lands [Accessed 8th July 2021].
[50] World Bank, Indigenous Peoples, 2021. https://www.worldbank.org/en/topic/indigenouspeoples [Accessed 8th July 2021].
[51] United Nations, Indigenous Peoples, Indigenous Voices, Factsheet, United Nations Permanent Forum on Indigenous Issues, 2006. https://www.un.org/esa/socdev/unpfii/documents/5session_factsheet1.pdf. (Accessed 8 July 2021).
[52] Martinez Cobo, José, Study of the Problem of Discrimination against Indigenous Populations, Volume V 'Conclusions, Proposals and Recommendations, United Nations, ' New York, 1987. https://www.un.org/development/desa/indigenouspeoples/publications/martinez-cobo-study.html [Accessed 8th July 2021].
[53] M.A. Peters, C.T. Mika, Aborigine, Indian, indigenous or first nations? Educ. Philos. Theor. 49 (13) (2017) 1229–1234. https://www.tandfonline.com/doi/full/10.1080/00131857.2017.1279879 [Accessed 17th May 2022].
[54] K. Northon, NASA Launches Mission Equity, Seeks Public Input to Broaden Access, NASA Press Release, 2021. June 15th 2021, https://www.nasa.gov/press-release/nasa-launches-mission-equity-seeks-public-input-to-broaden-access [Accessed 17th May 2022].
[55] Conservation International, Earth Observations for Indigenous Led Land Management, 2021. https://www.conservation.org/projects/earth-observations-for-indigenous-led-land-management [Accessed 8th July 2021].
[56] NPR, Perseverance Rover Will Be Naming Mars Landmarks in the Navajo Language, 2021. https://www.npr.org/2021/03/17/978288277/perseverance-rover-will-be-naming-mars-landmarks-in-the-navajo-language?t=1618051955783 [Accessed 8th July 2021].
[57] NASA, NASA's Perseverance Mars Rover Mission Honors Navajo Language, 2021. https://mars.nasa.gov/news/8886/nasas-perseverance-mars-rover-mission-honors-navajo-language/ [Accessed 8th July 2021].
[58] IAU, Gazetteer of Planetary Nomenclature, 2010. https://planetarynames.wr.usgs.gov/Feature/3523 [Accessed 8th July 2021].
[59] R.B. Leishner, T. Hogan, The View from Space: NASA's Evolving Struggle to Understand Our Home Planet, Kansas University Press, Lawrence Kansas, 2019.
[60] G. Denis, D. Alary, X. Pasco, N. Pisot, D. Texier, S. Toulza, From new space to big space: how commercial space dream is becoming a reality, Acta Astronaut. 166 (2020) 431–443.
[61] D. Kim, The Democratization of Space' and the Increasing Effects of Commercial Satellite Imagery on Foreign Policy, Center for Strategic & International Studies, 2019. https://www.csis.org/democratization-space-and-increasing-effects-commercial-satellite-imagery-foreign-policy [Accessed 8th July 2021].
[62] M. Elvis, Asteroids: How Love, Fear, and Greed Will Determine Our Future in Space, Yale University Press, New Haven, 2021.
[63] NASA, Blending Science and Tradition: Sharing Remote Sensing Technologies with Indigenous Communities and Their Land, 2020. https://www.nasa.gov/feature/blending-science-and-tradition-sharing-remote-sensing-technologies-with-indigenous [Accessed 14th July 2021].
[64] N. Tulley, M. Ecker, Managing the Navajo Nation's Water Resources with NASA Data, NASA, Applied Sciences Division, 2021. https://appliedsciences.nasa.gov/our-impact/people/managing-navajo-nations-water-resources-nasa-data [Accessed 8th July 2021].
[65] A. Ahrends, P.M. Hollingsworth, P. Beckschäfer, H. Chen, R.J. Zomer, L. Zhang, M. Wang, J. Xu, China's fight to halt tree cover loss, Proc. R. Soc. B 284 (2017), 20162559.
[66] V.A. Sokolov, Problems of forest planning in Russia, Sibirskij Lesnoj Zurnal (Sib. J. For. Sci.) 1 (2021) 3–12. https://sibjforsci.com/articles/sokolov-v-a-problems-of-forest-planning-in-russia-/ [Accessed 14th July 2021].
[67] J. Nalewicki, Before Going to the Moon, Apollo 11 Astronauts Trained at These Five Sites, Smithsonian Magazine, 2019. July 17th 2019, https://www.smithsonianmag.com/travel/going-moon-apollo-11-astronauts-trained-these-five-sites-180972452/ [Accessed 17th May 2022].
[68] T. Milligan, Civil Disobedience: Protest, Justification and the Law, Bloomsbury, London, 2013.
[69] M. Heidegger, Building dwelling thinking, in: Martin Heidegger *Basic Writings*, David Farrell Krell, London, 2008, pp. 343–364. Harper Perennial.
[70] C. Taylor, *A Secular Age* Cambridge Mass, Harvard University Press, 2007.
[71] I. Yefremov, Andromeda, A Space-Age Tale, Amsterdam, Fredonia, 2004.
[72] W. Zelinsky, The Cultural Geography of the United States, Prentice-Hall, Hoboken, 1972.
[73] T. Milligan, Fear of freedom: the legacy of Arendt and Ballard's space skepticism, in: C. Cockell (Ed.), The Meaning of Liberty beyond Earth, Springer, Heidelberg, New York and London, 2015, pp. 33–45.
[74] R. Zubrin, Entering Space, Creating a Spacefaring Civilization, New York, 2000. Putnam.
[75] J. Arnould, Impossible Horizon, ATF Press, Adelaide, 2017.
[76] T. Milligan, Nobody Owns the Moon: the Ethics of Space Exploitation, McFarland and Company, Jefferson NC, 2015.
[77] J.S.J. Schwartz, The Value of Science in Space Exploration, Oxford University Press, Oxford, 2020.
[78] I. Yefremov, Chas Bayk, Druzhba Narodov, Moskva, 1994.
[79] M. Bender, The Nuosu Book of Origins: A Creation Epic from Southwest China, University of Washington Press, Seattle, 2019.

[80] M. Bender, Landscapes and life-forms in cosmographic epics from southwest China, Chinese Literature Today 5 (2) (2016) 88–97.
[81] A. Bebbington, J. Bury, The political ecologies of the subsoil, in: A. Bebbington, J. Bury (Eds.), Subterranean Struggles: New Dynamics of Mining, Oil, and Gas in Latin America, University of Texas Press, Austin, 2013.
[82] J.E. Lovelock, L. Margulis, Atmospheric homeostasis by and for the biosphere: the Gaia hypothesis, Tellus 24 (1974) 2–9.
[83] J.E. Lovelock, A physical basis for life detection experiments, Nature 207 (1965) 568–570. https://www.nature.com/articles/207568a0.pdf [Accessed 17th May 2022].