

Waxing Knowledge, Waning Moods

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Abstract: A prominent difference between the modern age and the contemporary age is the overall attitude towards the idea of progress. This includes the idea of the progress of knowledge (arguably scientific progress), which seems to stand in stark contrast to the actuality of ever growing scientific and technological capacities of present times. Modern age was decidedly optimistic regarding the outlook of scientific progress, but contemporary times are a lot more pessimistic. A motif useful for understanding this peculiarity can be found in the evolution of science fiction through these ages. To that end, three representative works of science fiction that are plot-wise directly related to the Moon are analysed: Johannes Kepler's *Somnium*, Arthur Clarke's *A Fall of Moondust* and Neal Stephenson's *Seveneves*. Their comparison reveals that the plot points in these works become progressively more catastrophic, which only correlates with the rising pessimism of contemporaneity, but is more directly linked to the greater knowledge about the Moon that is available. In *Somnium*, Kepler could only work with telescopic observations; *A Fall of Moondust* was written just before the Moon landings and appropriately deals with a local crisis on the Moon; finally, *Seveneves* explores a global critical event that is an existential risk to the entire humankind. This shows a progressive maturing of our world view, from an early naive optimism, towards sobering realizations about significant risks that humanity can face. In that context, current pessimism is seen as a stage in which our kind acknowledges that progress and betterment are not guaranteed of themselves. This pessimism, however, ought to be eventually overcome in an assertive way with prudent plans for a sustainable future of humanity.

Keywords: existential risk; pessimism; progress; science fiction; utility of knowledge

I. Contemporary pessimism

Few would be willing to argue against the idea that recent generations possess quantitatively greater knowledge than their predecessors. We know more. More natural phenomena are understood; more facts are readily accessible to more people than ever; more abundant are our

archives and libraries. Many would agree that our knowledge is qualitatively better as well, although there might be slightly less unanimity on that front. We know better. Our instruments are better today than in the past; our scientific methodology has been refined and improved through many iterations of trials and errors and brilliant flashes of insight; our experimental capacities are greater, not to mention that the computing power available to us is steadily increasing.

One could say we are at the threshold of the enlightened man's dream, or, at the very least, that we are on a steady course towards it. Yet for all the hypothetical mirth our seventeenth-century ancestors might express upon seeing our world, the attitude of contemporaneity is far more subdued, perhaps even reserved. Things are improving, but not nearly as reliably as we expected, or, perhaps, hoped. We produce far more food than we need, and still there are people who go hungry;¹ there are still fatal diseases taking many lives, not necessarily for the lack of cure, but for the lack of infrastructure or, worse, lack of trust in the cure;² we have witnessed remarkable breakthroughs that augment the free flow of information, but misinformation is also adept at flowing through these channels.³ The likes of Steven Pinker would optimistically remind us that we live in the best of times by so many parameters: longer average lifespan, fewer violent deaths, greater literacy.⁴ But this is of little consolation for those who are still hungry or poor in this world of abundance. The very concept of progress is often called into question. With all the blessings of today in mind, whence-

¹ Eric Holt-Giménez, et al, "We Already Grow Enough Food for 10 Billion People... and Still Can't End Hunger," *Journal of Sustainable Agriculture* 36, no. 6 (2012): 595-598, <https://doi.org/10.1080/10440046.2012.695331>.

² Eve Dubé, et al., "Vaccine Hesitancy: An Overview," *Human Vaccines & Immunotherapeutics* 9, no. 8 (2013): 1763-1773.

³ Victor Suarez-Lledo, and Javier Alvarez-Galvez, "Prevalence of Health Misinformation on Social Media: Systematic Review," *Journal of Medical Internet Research* 23, no. 1 (2021): e17187.

⁴ Steven Pinker, *Enlightenment Now* (New York: Viking, 2018).

forth stems the discontentment of so many people? The mood of modernity was that of optimism for the future; why is the mood of contemporaneity so opposedly sombre, pessimistic?

Is it perhaps due to man's hubris, our primal greed driving us to covet what we do not have evermore? Is the improvement of human welfare an exercise in futility, whereby as soon as one issue is resolved, another is found and put in its stead? There are certainly some contemporary grievances that can be ascribed to people getting used to greater creature comfort of today – these would be pejoratively called “first-world problems”: having to wait minutes rather than seconds to download the latest film, not being able to reserve a table at the favourite restaurant because it is overbooked and so on. But these are trivialities, at worst annoyances for an affective moment and at best used as points of comedic self-reflection.

Is it perhaps that *conditio humana* is marred by some kind of eternal curse, akin to the biblical punishment for the original sin, that leaves our souls constantly restless? Maybe it is the ubiquitous fear of death, of loss (“for dust thou art, and unto dust shalt thou return”⁵), or the realization that pain and suffering cannot be eliminated from our lives (“in sorrow thou shalt bring forth children”⁶), or the constant reminders that nothing is gained without significant effort (“In the sweat of thy face shalt thou eat bread”⁷). But these are issues humanity has been facing for millennia, and there is little reason to think those problems would cause more grief today than in the past. If anything, the abundant opportunities for distraction that exist today would provide an effective method of escapism. Furthermore, this hypothetical unremitting nature of these aspects of human condition is barely provable. That which was once thought damning may yet be conquered, as we have already done in the case of eradication of smallpox. It is precisely the advancement of medical science that opened the door for such a possibility.

⁵ *Genesis*, 3:19

⁶ *Genesis*, 3:16

⁷ *Genesis*, 3:19

But there's the rub. Far more devastating for our morale are the issues which are neither trivial (restaurant seating) nor seemingly insurmountable (death), but rather those for which the solution is just above the horizon, and somehow still out of reach. Consider, for instance, the proliferation of nuclear armaments during the Cold War. We can leave aside the chilling calculations of using nuclear weapons to shorten the length of World War II, and focus on the issues that arose afterwards. The nature of these dreadful weapons is such that the only sensible way of defence against them was seen in deterrence. This led to the emergence of the MAD doctrine ("Mutually Assured Destruction," a Nash equilibrium in which two opposing sides each possess the capability to utterly destroy the other, resulting in no side wanting to initiate the conflict for fear of maximum retaliation), prompting the United States and the Soviet Union to enter into an arms race. The only position in which the entire world was safe was when it was teetering on the razor-thin edge of this mutually assured destruction. And this wasn't some natural calamity, a work of a higher power, but something we brought about with our own hands. Somehow, during the Cold War, the best defender of life was the possibility of a gruesome death.

II. Reframing the question

In the previous example we may have stumbled upon a crucial clue. The situation that was just described is, simply put, contradictory, absurd. It is easy to imagine how an abundance of such situations would cause discontent. Of course, there are plenty of authors who spoke of human condition as a conflict between opposing forces⁸ or a perpetual state of absurdity.⁹ The scope of our interest is far narrower at this moment. We do not wish to diagnose the entirety of human existence, we merely

⁸ Sigmund Freud, *Jenseits des Lustprinzips* (Wien: Internationaler Psychoanalytischer Verlag, 1921).

⁹ Albert Camus, *The Myth of Sisyphus* (New York: Vintage International, 2018).

wish to inquire into the roots of a peculiar phenomenon: why do we today tend to be less optimistic than our predecessors, in spite of being more knowledgeable than them? Shouldn't greater knowledge lead to more possibilities and thus to better outlook towards the future? Indeed, but not all possibilities are created equal, and not all of them shine a light on a desirable tomorrow. The only thing we can claim for certain is that the greater the knowledge we possess, the more numerous the known consequences of that knowledge will be. Perhaps there is a particular set of consequences that all share a common nature which would explain the contemporary pessimism. Let us try and bring these specific consequences into focus.

Firstly, the consequences that we speak of must somehow be self-imposed, that is, they must be an appreciable result of humanity's own actions, in order to differentiate them from the circumstances that are simply encountered and thought of as inevitable. The frightful prospect of inexorable death isn't emblematic of our time, but of all times. In other words, a scenario must be conceivable in which the consequences do not occur; for instance, the overabundance of food we produce is worth little when the distribution of wealth in the world is so unequal and a better one can be imagined. Secondly, the consequences must be of a contradictory nature, specifically such that they cannot be removed by simple negation. The Cold War nuclear arms race fulfils both of these criteria: nuclear weapons are a scientific, technological and political product of humanity, had we not discovered how to split the nucleus of an atom, these weapons would be unknown; nuclear threats could not be solved by one-sided reduction of the number of warheads, as it would place one conflicting party, as well as the whole world, at a catastrophic disadvantage.

An important note must be made here: the grim consequences that we are linking with the contemporary world are not to be understood simply as new, never-before-seen challenges, but rather as challenges the nature of which is seemingly at odds with all the improvements made in a certain area so far. For instance, climate change, as dreadful an issue as it is, is

merely new, but not truly contradictory to the idea of industrial, economic and scientific progress. It is only sensible that the greater our technical capacity grows, the greater impact it will have on the surrounding world. Even the “opponents” of climate change cannot deny that human activity has an effect on the environment, they mostly dispute the extent of the impact. And this opposition, while undoubtedly detestable, isn’t without its own twisted reasons. Scientific consensus on the issue of climate change is clear and climate change deniers are, simply put, representatives of a conflicting interest. On the one hand, there is the long-term interest of sustainability of Earth’s biosphere, on the other hand there is the short-term interest of using fossil fuels to turn a quarterly profit. In the current state of affairs, these two interests are conflicted, and in due time, one side will ultimately have to surrender. The uncertainty of which side will emerge victorious is terrifying, but not unfathomable. Climate change is self-imposed, but the path to its elimination is quite clear except for the lack of willingness of the most offending contributors to undertake it.

The grim circumstances we are talking about are cut from a whole different cloth. It is the absurd case of more weapons being the only way to no weapons used. The uncanny rise of conspiratorial and paranoid modes of thinking is arguably of a similar origin. The Internet is rightfully one of the most impactful breakthroughs in communication technologies. It has connected a vast number of people in the world in an unprecedented way. But it has also opened the doors for a number of terrors to escape into the world. Previously, if an errant paranoid thought emerged in a single mind, more often than not it would fizzle out because its sustenance wasn’t readily available and it couldn’t be shared effectively. Now, all it takes is a couple of clicks both to find similar thoughts for it to feed on and to offer it as food for other kindred thoughts. Furthermore, social media platforms have an inherent incentive to foster such activity, as controversial content garners more user engagement.¹⁰

¹⁰ Luke Munn, “Angry by Design: Toxic Communication and Technical Archi-

This was perhaps a most convoluted way to describe the so-called “echo chambers” of the Internet, but it was essential to illustrate how the rise of pseudoscientific beliefs such as the flat Earth movement and anti-vaccination movement fulfils the aforementioned criteria. First, they are self-imposed, as they wouldn’t be nearly as prominent or numerous if it weren’t for the contemporary free flow of information. Second, they cannot be simply refuted (negated), as any opposition to such ideas is by definition seen as an instrument of “the powers that be” in the eyes of the adherents of these movements.

So here we are today: after years of space travel, after decades of developing inoculation techniques, after centuries of research into orbital mechanics and pathology, all of which is relatively easily available, the world still has to deal with naysayers in these areas. Some might say that an occasional case of paranoia is inevitable. However, where once we encountered but pockets of errant noise, now we face a clamour of rising pitch that is difficult to ignore as it is beginning to affect the practical outcomes of our daily lives. To make matters worse, the most extreme versions of these narratives are not the ones that do the most damage, but rather those that seem more moderate, more credible, more believable. The lower-than-expected rates of vaccination against COVID-19 in some parts of the world are not to be blamed solely on flippant ideas that vaccines are some method of alien mind-control; in fact, most hesitancy can be linked with the fear that vaccines are not sufficiently tested.¹¹ Not every conspiracy needs to be outlandishly comical to have a noticeable effect.

And there we find the most insidious aspect of these conspiratorial movements. Most of them are obviously anti-intellectual because their core ideas are at odds with what is accepted by the wider scientific community, yet some wear the trappings of intellectualism. Both the flat Earth movement and the anti-vaccination movement will claim that they espouse a healthy

ture,” *Humanities and Social Sciences Communications* 7, no. 53 (2020): 1-11.

¹¹ Marie Pierre Tavolacci, Pierre Dechelotte, and Joel Ladner, “COVID-19 Vaccine Acceptance, Hesitancy, and Resistancy among University Students in France,” *Vaccines* 9, no. 6 (2021): 654-667.

scepticism towards authority, open-mindedness towards unconventional ideas and importance of discovering things on one's own. These would all be admirable qualities of an enlightened person, a freethinker, so to speak. And anyone questioning the tenets of their movements is favouring dogmatism, close-mindedness and gullibility – thus is evidently an enemy of the light of reason.

To a certain extent, these anti-intellectual movements are both the cause and the result of pessimistic tendencies of the contemporary world. As a cause, their very existence can bring despair into the hearts of others, who might now worry that both education and common sense failed mankind. But this can be explained away as simple optics: these movements are so prominent not because they are numerous, but because their ideas are so grotesque that they become instantly visible even if a minority. It is a lot more fruitful to regard these tendencies as symptoms of pessimism in itself and to ask what would drive another person towards such outrageous ideologies, even when the evidence for the opposite is so readily available.

A similar issue was famously explored by Max Horkheimer in his work *Eclipse of Reason*. Motivated by the question of how Nazi ideology managed to garner assent of so many regular people in spite of all the civilizational advances made thus far, Horkheimer poignantly notes:

The hopes of mankind seem to be farther from fulfilment today than they were even in the groping epochs when they were first formulated by humanists. It seems that even as technical knowledge expands the horizon of man's thought and activity, his autonomy as an individual, his ability to resist the growing apparatus of mass manipulation, his power of imagination, his independent judgment appear to be reduced. Advance in technical facilities for enlightenment is accompanied by a process of dehumanization.¹²

¹² Max Horkheimer, *Eclipse of Reason* (London: Continuum, 2004), v.

Horkheimer's conclusion is that this crisis is the result of objective reason (one that regards universal truths and goals) being supplanted by subjective reason (one that focuses on immediate means in an isolated situation). This upending was, in his view, principally supported by positivist and pragmatist philosophies, and these bear the greatest brunt of Horkheimer's critique in the entire book. Instrumentalisation of thoughts and ideas ultimately lead to situations in which any end, no matter how revolting in itself, can find justification merely by providing adequate means of its own realization.

With the focus of the book being directed at over-reliance on pragmatism and broader susceptibility to manipulation by political ideologies that can stem from it, Horkheimer's account does not provide an angle for the more specific circumstance in which utilized knowledge leads to reduced trust in its utility. If anything, scepticism towards the contemporary perversion of a modern ideal would itself be a sign of disenchantment, a prequel to pessimism.

Horkheimer provided several admirable insights, and a particularly poignant one asserts the risk of pragmatist criterion of "truth as usefulness" becoming twisted into a tool for control where truth is measured by usefulness to some established group.¹³ Unfortunately, there are other arguments to be found there that are at best dated views. For instance, Horkheimer's equating of contemporary science with the positivist doctrine of verification¹⁴ is now an antiquated position in philosophy of science. Consequently, his claim that acceptance of scientific method represents a *petitio principii* with regards to finding scientific truth¹⁵ loses a significant edge. With such constraints, *Eclipse of Reason* is more of another instance of contemporary pessimistic mood (albeit more thoroughly thought through than other examples) than an explanation for it that we seek.

¹³ Ibid., 59.

¹⁴ Ibid., 29, 52.

¹⁵ Ibid., 52.

What Horkheimer's critique does reveal well is that the trouble stems from the manner in which knowledge is utilized. Ostensibly, there seems to be a misalignment between implementing knowledge outwardly (applying it to the outside world) and implementing it inwardly (interiorising it into understanding). One might be tempted to explain this misalignment by calling out overspecialization of sciences or the inability of any one individual to possess the sum total of human knowledge, but neither of these explanations can account for the core issue, the simultaneous rise of effectiveness and loss of perceived trust in knowledge. If anything, overspecialization would stimulate increased trust, as each person from their own narrow field could appreciate the extent of knowledge other specialists possess, confirmed by effectiveness of each of those fields. The rift between the mood of the modern era and the mood of the contemporary era is still shrouded in mystery.

III. Every tale holds a morsel of truth

In the attempt to approach this issue from another standpoint, instead of analysing knowledge and science of these eras themselves, we will rather consider how humanity *wrote* about knowledge and science in these eras. After all, our primary concern is not the actual state of these activities (as already mentioned, they are thriving), but more so the mismatch between that state and how they are *perceived*. To that end, fictional works that have science and technology as core topics ought to prove more useful than academic papers or historical records. Certainly, *science fiction* would be the genre we are looking for.

There are multiple subgenres of science fiction. The best-known division is by "hardness": *hard science fiction* encompasses works where the author adhered as strictly as it was possible to the known laws of nature and limits of technology and tended to explain the workings of fantastical elements of the story in greater detail; and *soft science fiction* covers works in which the author took more liberties with fantastical elements, either by offering insufficient explanations ("hand-waving"), using mean-

ingless jargon (“technobabble”) or downright ignoring the reasons for out-of-the-ordinary pieces of the story. Of these two, hard science fiction seems more suited for the needs of this paper, and the harder the better – the more rigorously the author has to follow the rules of science and logic, the more clearly we will be able to glean what is the author’s attitude towards them.

Still, analysing all of the works of hard science fiction would be a monumental task. We ought to find a specific topic, perhaps one that is somehow meaningfully connected with the transition of the periods we are regarding. Horkheimer might be useful here once again. In one of the more poetic visions in *Eclipse of Reason*, he comments how the utilitarian outlook can pervert even the most tranquil of sights:

The story of the boy who looked up at the sky and asked, ‘Daddy, what is the moon supposed to advertise?’ is an allegory of what has happened to the relation between man and nature in the era of formalized reason. On the one hand, nature has been stripped of all intrinsic value or meaning. On the other, man has been stripped of all aims except self-preservation. He tries to transform everything within reach into a means to an end. Every word or sentence that hints of relations other than pragmatic is suspect. When a man is asked to admire a thing, to respect a feeling or attitude, to love a person for his own sake, he smells sentimentality and suspects that someone is pulling his leg or trying to sell him something. Though people may not ask what the moon is supposed to advertise, they tend to think of it in terms of ballistics or aerial mileage.¹⁶

The Moon – our eternal companion; a fairly reliable timepiece; the first and so far only celestial neighbour we set foot upon; it is our visit to Luna that definitely shattered the crystal spheres

¹⁶ Ibid., 69.

of the sky and confirmed Sir Isaac Newton's conviction that the world beyond is, in fact, just the world. Surely the day we look upon the Moon with utter cynicism will be the low point of humanity, when jadedness will have taken the place of wonder. And, in a convenient order of events, our arrival at the Moon in the second half of the twentieth century nicely coincides with the shift from the modern view of knowledge to the more contemporary one.

If we suspect we might find echoes of that shift in fiction, then hard science fiction stories about the Moon are a good place to conduct the search. There are a couple of other benefits from choosing this topic, both stemming from the Moon's relative vicinity. First is the fact that our familiarity with the Moon gives authors the possibility to write *very hard* science fiction about it; second, this familiarity also guarantees that there will still be a wide array of appropriate works to choose from. With that in mind, we ultimately narrowed our selection to three representative works written by some of the most prominent names in science fiction history. The first work is chosen to represent the pure modern view, the time when Moon was still only seen and not yet touched. The second work represents the transitory period, the time of the first lunar landing, and the slow change from modern to contemporary view. The final work is the most recent and it represents the contemporary view and the condition in which we find ourselves today.

a. *Somnium*

The first hard science fiction work about the Moon that is going to be considered, and arguably the first science fiction story about the Moon altogether, is Johannes Kepler's *Somnium* (*Dream*). In this story, written by the astronomer at the beginning of the seventeenth century, the author recounts an unusual dream involving a fantastic journey. In this dream we meet a youth from Iceland called Duracoto and his mother Fiolxhilde. The young man, although clever, never learned how to read or write and instead helped his mother in gathering cere-

monial herbs. However, after an unfortunate accident, his irate mother sells him to some seafaring merchants who happen to take him all the way to meet Tycho Brahe himself, whereupon the astronomer teaches Duracoto both Danish and astronomy. During this stay, the young man notices that many things he learns about the Moon from Brahe were already told to him by Fiolxhilde. After five years, Duracoto returns to his mother in Iceland, who is overjoyed to see that her son has become a follower of science.

An interesting image of knowledge is painted at the beginning of this story: both Duracoto and Fiolxhilde are knowledgeable, but in significantly different ways. Fiolxhilde, although never explicitly stated as such, is evidently a witch or a medicine woman, as she works with medicinal and ceremonial herbs, of which she knows not through education, but through some inherent wisdom of hers. In fact, she made sure her son didn't learn how to write, though not because she thought writing was bad in and of itself, but because "there are many pernicious despisers of the art who would slander that which they do not understand."¹⁷ Apparently, rulers of their communities did not look favourably upon those who sought to expand their horizons of knowledge, and passed laws penalizing such acts. However, Duracoto (who is, notably, a male) manages to eschew these laws and receive strict scientific education in the safety of a foreign land. The only danger that Kepler is willing to link with knowledge is the danger posed by those who lack of it; otherwise, to know is to be in a better position to learn even more about the world. This is seen when Fiolxhilde decides that only after five years of study under Brahe is her son worthy of learning the mysteries she was privy to for many years of her long life.

And how would an uneducated witch possess knowledge about the Moon greater than even that of the world's greatest astronomer? Why, by revelation, of course: Fiolxhilde regular-

¹⁷ Johannes Kepler, *Der Traum vom Mond* (Leipzig: B. G. Teubner, 1898), 3 (translation mine).

ly converses with spirits that frequent Iceland, who tell her of many distant shores. One of these shores is the land of Levania, or as we know it, the Moon. Fiolxhilde then summons this spirit (at a crossroads, no less), so that her son can learn about this amazing place.

The spirit's account of the Moon is very detailed, and includes its size, distance, climate and even the way other stars and constellations look like when observed from the surface of the Moon. There is also the description of the denizens of the different regions of the Moon: "the Subvolvans" live on the hemisphere that always faces the Earth ("Volva" as they call it), they experience milder climate and are commensurably milder people; "the Privolvans" live on the hemisphere always facing away from the Earth and are a lot tougher people due to more extreme weather they must endure (direct sunlight and utter darkness without Earth's mitigating influence).¹⁸

The majority of Kepler's descriptions of Levania are founded in astronomical observations of the Moon, and in fact would not require a revelation by an alien spirit. Even the most complex accounts of how the sky looks like from the various points on Moon's surface is merely a matter of taking how the sky looks like from Earth and then applying appropriate astronomical adjustments. Some of the most amusing moments from the story are Kepler's attempts to describe how the Earth's geography looks from the Moon: instead of describing the usual shapes of continents, the Lunar spirit uses the images of a young lady blowing a kiss, of a cat, a bell and so on.¹⁹

True fantastical elements of this story occur towards its end, when Kepler begins to speculate on how the other side of the Moon looks like and what kinds of creatures would inhabit it. One must keep in mind that in Kepler's time, nobody has even laid eyes upon *the dark side of the Moon*. Namely, our satellite is tidally locked with Earth such that its one side always faces towards it and the other always faces away. First images of the

¹⁸ Ibid., 11-12.

¹⁹ Ibid., 15-16, and 114-117.

Moon's other side were taken in 1959. Before that, this "dark" or "far" side was always a synonym for something unknown, and a perfect place where authors could let their fancy run wild. Kepler, however, was rather conservative in his imagination: he reasoned that the Privolvans that live there must be hardy and resourceful folk, seeking shelter underwater and underground and riding various beasts or sometimes even using airships.²⁰ Apparently, even the most hostile of Moon's environments still enabled exciting lives. Unfortunately, before more of these scintillating accounts could be expressed, Kepler suddenly awakens, and his dream vanishes from his mind.

The Moon of this Kepler's story is a tranquil place. There are only two instances when it was depicted as inhospitable: first time, when the spirit describes how difficult the journey from Earth to Levania is, due to distance, travel speeds, cold and lack of breathable air; the second time is when the spirit describes the extreme weather that occasionally befalls the far side of the Moon. Neither of these instances is an active obstacle for the story, as there are already ample ways of ameliorating these unfavourable conditions: Earthlings must be of peak physical strength before attempting the trip and are put in a state of suspended animation for its duration; the Privolvans have developed the capability of living underwater and their technology helps them overcome the hostilities of nature.²¹ There may be challenges on the Moon, but solutions are also readily available.

After all, is that not what would happen when denizens of a world acquire great knowledge about their home? Kepler seems to present Selenites as both exotic and exemplary, and their mastery over the Moon is quite understandable: Luna is a lot smaller than the Earth, so her secrets are quicker to be uncovered by the native people. The task of humanity, both literal and metaphorical, is now to rise to the occasion and reach these Moonfolk. With such a perspective, Kepler's outlook is markedly modern: optimistic regarding the capabilities of knowledge

²⁰ Ibid., 20.

²¹ Ibid., 20.

and the upward direction of the development of mankind. And he is not alone in this vision. There are other early science fiction stories that depict alien cultures as “humanity only more mature.” For instance, *The Man in the Moone* tells of Lunars who are impeccable Christians,²² quite unsurprisingly as the author, Francis Godwin, was a bishop. Naturally, there will be works of science fiction that will soon break away from this mould, and it is precisely these differences that will be in the focus of our attention onwards.

b. *A Fall of Moondust*

The second piece of science fiction about the Moon that we are going to analyse here is Arthur Clarke’s *A Fall of Moondust*. Widely considered one of his best works, this novel was written in 1960, several centuries after Kepler’s *Somnium* and Godwin’s *The Man in the Moone*. And those were rather eventful centuries, both with regards to the development and popularization of science fiction as a literary genre, and with regards to improved astronomical observations and a substantial increase of our knowledge about our natural satellite. During that time, we learned a lot about the Moon: its visible surface was mapped with telescopes and later extensively photographed; the far side of the Moon was only just observed the year prior and no longer symbolized something unknowable; the Moon’s geographic (perhaps more accurately *selenographic*) features were documented and theories of their nature and origin began to form. However, one crucial element was missing. All of the findings about the Moon during that period were made at a distance. Sight was almost the exclusive way of gathering empirical evidence about the Moon, and no matter how highly sophisticated instruments were used to do that, relying on a single channel for information is never foolproof. Many lunar theories of those times would remain underdetermined, hypothetical, even speculative, until different kinds of data were available. We simply couldn’t know for sure until we got there.

²² Francis Godwin, *The Man in the Moone* (London: Joshua Kirton, 1657), 73.

A Fall of Moondust appeared at a crucial time, just a few years before Neil Armstrong became the first man on the Moon, before even the first robotic probes landed there. That makes this novel extremely relevant to our inquiry, because it was written at the time when our knowledge-at-a-distance about the Moon was at its highest, when we had an abundance of possible theories about the Moon just waiting to be verified or falsified. One of these theories claimed that lunar surface is covered by extremely fine dust, so fine that vehicles and personnel that find themselves on it might be at a risk from sinking into it with fatal consequences. Clarke comments on this very issue himself:

Yet, in 1960, such an outcome was a very real fear. Through a powerful telescope, vast areas of the lunar plains appear exceedingly flat and smooth, and a number of astronomers (notably Dr Thomas Gold) had maintained that they were indeed composed of extremely fine dust. Over billions of years, they argued persuasively, the ferocious changes of temperature between day and night would break up and eventually pulverise the local rocks. [...] When the Luniks and Surveyors landed on the Moon during the mid-60s, the designers of the Apollo spacecraft were able to relax. All the robot probes remained just where they landed, their footpads barely denting what looked like perfectly ordinary dirt.²³

The novel is centred on the disaster that befell *Selene*, a luxury tourist vessel that sails the fictional “Sea of Thirst” on the Moon. This sea is not filled with water, but with very fine dust, which, in conjunction with the Moon’s low gravity and lack of atmosphere, behaves in some aspects as a fluid and in some as a solid. On one of *Selene*’s voyages, an unexpected moonquake causes the dust to shift dramatically and swallow the ship whole with her crew and passengers. The novel then follows the strug-

²³ Arthur Clarke, *A Fall of Moondust* (London: Gollancz, 2002), 5.

gles of these people to escape a dire fate, as well as the efforts of people on the surface helping them. Of note is that the cast includes diverse but competent and knowledgeable characters: key actors inside the ship are not just the veteran spacefarers, but also a detective and a physicist, while surface rescuers are not limited to on-site first responders, but also include astronomers, geophysicists, habitat governors and the like. More often than not, specialized knowledge of these characters will play a vital role in furthering the plot of this novel.

As we came to expect from Arthur Clarke, the novel is scientifically very accurate. However, the entire plot of the novel hinges on the possibility that lunar surface has at least areas covered in superfine dust that might swallow a large vessel. We now know that such a place does not exist on the Moon, but at the time of this novel's inception, we knew and didn't know just enough about it that such a scenario was plausible. Distance was an operative factor, and Clarke offers a rather poetic reverse reflection on that:

Everyone of the twenty-two men and women aboard *Selene* looked up at that blue-green crescent, admiring its beauty, wondering at its brilliance. How strange that the familiar fields and lakes and forests of Earth shone with such celestial glory when one looked at them from afar! Perhaps there was a lesson here; perhaps no man could appreciate his own world, until he had seen it from space.²⁴

Even the very familiar Earth seems foreign when viewed from a sufficient distance. What the lunar tourists thought they knew well appeared as not known at all. As a matter of fact, the way Clarke addresses the aspects of knowing and not knowing in this novel is rather telling and representative of the general attitude towards this new frontier in science, technology and exploration.

²⁴ Ibid., 18.

Arguably, the Moon as we know it today is less dangerous than the one in this novel, at least for the lack of a “Sea of Thirst.” This isn’t to say other hazards hadn’t been discovered later. What is notable is that the Moon from *A Fall of Moondust* is significantly more actively deadly than the one from *Somnium*. Apparently, even before we set foot on it, we gathered enough knowledge to be able to quite convincingly speculate about what might go wrong. It is as if the more we know how things *are*, the more we are aware how we would rather things *wouldn’t be*. Knowing does not only entail mastery, but even more so the awareness of how easily that mastery would be lost. But even with the growing awareness of unfavourable outcomes, the sentiment of the novel is ultimately optimistic. It may be suspenseful at times, but quick wit and ingenuity always seem to prevail.

This optimism is not unconditional, however. Towards the final quarter of the novel, a tragic complication occurs: just as the rescue team was about to reach the buried moonship, the water that was slowly evaporating from *Selene* and entering the surrounding dust, causes it to sink further away from rescuers’ reach. This event is effectively contrasted with the initial catastrophe that buried the vessel: “It had taken nature a million years to set the trap that had snared *Selene* [...] The second time, she was caught in a trap that she had made herself.”²⁵ So, for all the human ingenuity, this final twist in the story effectively reminds us that some challenges we face are of our own doing – not necessarily a direct or intended consequence, but still inextricably linked with our actions. An optimistic view of mankind’s abilities was warranted, but it had to be tempered, bridled so to speak.

No other character in the novel exemplifies this bridled optimism better than Tom Lawson, a skilled and headstrong astronomer with a poor outlook on other people and even poorer social skills. He was instrumental in rescue team’s efforts of locating *Selene* under the dust, however, the reason for his unbreakable spirit was quite peculiar:

²⁵ Ibid., 180.

Tom hated to admit defeat, even in matters far less important than this. He believed that all problems could be solved if they were tackled in the right way, with the right equipment. This was a challenge to his scientific ingenuity; the fact that there were many lives involved was immaterial. Dr. Tom Lawson had no great use for human beings, but he did respect the Universe. This was a private fight between him and It.²⁶

But even such an indomitable spirit would be humbled in the course of this novel. While testing an infrared scanning device, Lawson directed it towards the Earth and saw, much like the lunar tourists previously, a strikingly unfamiliar sight:

It was a reminder of the fact, which no scientist should ever forget, that human senses perceived only a tiny, distorted picture of the Universe. Tom Lawson had never heard of Plato's analogy of the chained prisoners in the cave, watching shadows cast upon a wall and trying to deduce from them the realities of the external world. But here was a demonstration that Plato would have appreciated; for which Earth was 'real' – the perfect crescent visible to the eye, the tattered mushroom glowing in the far infra-red – or neither?²⁷

Much of the novel has the same mildly cautionary tone. As was noted earlier, this fictional scenario was perceived as possible, if not probable, at the time of its inception. There are things that can go wrong in everyday events. Things can even more easily go wrong around delicate and extraordinary things such as a tourist voyage in a remote region of another celestial body.

²⁶ Ibid., 31.

²⁷ Ibid., 77.

But weaving a story about such a specific chain of events as the one that befell *Selene* requires knowing many minute factors and their complex interplays. There are many *similar* tales that involve ships sinking underwater, or people getting stuck in quicksand or otherwise being buried alive, but there aren't many other tales in which a moonship sinks into a sea of dust in such a plausible a way. For Clarke to even conceive of such a possibility, we first had to accumulate a lot of knowledge about the Moon. Only this time, gaining this knowledge didn't result in a story about a rosy utopia. The knowledge gathered presented an insight into a potential disaster.

In this aspect we can see how *A Fall of Moondust* diverges from the pure optimism of early science fiction. However, inasmuch as our increased knowledge makes us more observant of possible harm, it is at the same time the source of salvation from that very same harm. In that aspect, this novel is similar to early science fiction about the Moon. *A Fall of Moondust* is thus representative of a transitory state between modernity and contemporaneity. Not naively optimistic, but not yet pessimistic about the future, it carries itself and its vision of mankind's future with a sort of cautious optimism.

c. *Sevенеves*

The final work of science fiction about the Moon that is going to be analysed here is also the most recently published, Neal Stephenson's *Sevенеves* from 2015. Unlike the previous works that were available to the public for decades or centuries, there is a reasonable possibility that the readers of this article hadn't had the opportunity to read *Sevенеves*, so the analysis will be as vague about the plot details as possible, so as not to spoil anyone's enjoyment of this work. Fortunately, the most important event for this topic is encountered in the very first line of the book, arguably one of the most dramatic openings in science fiction: "The Moon blew up without warning and for no apparent reason."²⁸ It may seem strange at first that the plot that

²⁸ Neal Stephenson, *Sevенеves* (New York: Harper Collins, 2015), 3.

follows the sudden absence of the Moon should be considered in this investigation, but there is no denying that *Seveneves* is, among many other things, also about the Moon, even if the Moon is nowhere to be seen.

For those who encountered Stephenson's work before, *Seveneves* will be a quite expected sight. Sprawling at over 850 pages and filled to the brim with detailed and accurate technical descriptions, this book is an exemplar of *very* hard science fiction. Stephenson is well-known for devoting great effort into researching a particular topic and then writing voluminous works that are firmly planted in that knowledge. What his *Cryptonomicon* is for cryptography and *Anathem* is for classical philosophy, *Seveneves* is for aeronautics and orbital mechanics: a treasure trove of familiar references for those in the know and a deep well of detailed explanations for laypersons.

The core plot of the book is comprised of the many challenges humanity has to face in order to survive in the aftermath of such a cataclysmic event as the disintegration of the Moon. The character of Doctor Dubois Harris, a famous scientist and science popularizer, explains why Moon breaking up into several chunks is so catastrophic for everyone:

We'll see an increasing number of meteorite impacts. Some will cause great damage. But overall, life is not going to change that much. But then [...] we are going to witness an event that I am calling the White Sky. It'll happen over hours, or days. The system of discrete planetoids that we can see up there now is going to grind itself up into a vast number of much smaller fragments. They are going to turn into a white cloud in the sky, and that cloud is going to spread out. [...] A day or two after the White Sky event will begin a thing I am calling the Hard Rain. Because not all of those rocks are going to stay up there. Some of them are going to fall into the Earth's atmosphere. [...] By 'some' I mean trillions. [...] It is going to be a

meteorite bombardment such as the Earth has not seen since the primordial age, when the solar system was formed. Those fiery trails we've been seeing in the sky lately, as the meteorites come in and burn up? There will be so many of those that they will merge into a dome of fire that will set aflame anything that can see it. The entire surface of the Earth is going to be sterilized. Glaciers will boil. The only way to survive is to get away from the atmosphere. Go underground, or go into space.²⁹

And so begins a massive endeavour of mankind trying to avoid extinction, as Dubois' predictions are eventually realized. Unlike *A Fall of Moondust*, where the lives of some twenty-ish people were in jeopardy, *Seveneres* presents us with an even more dire scenario: an existential catastrophe, an extinction event. There are several other points of divergence between these two works.

Firstly, the characters in Stephenson's book are a lot more realistic and flawed. In *A Fall of Moondust*, most personae were exemplary of their expertise and virtue; space pilots are brave and composed, scientists can crunch numbers in the most difficult situations, and even if a character fault was exposed, it is most often overcome in a display of competence. The obstacles that the heroes of Clarke's novel have to face mostly come from the Sea of Thirst itself, and only very rarely from other humans. People in Stephenson's book are far more imperfect. There is treachery, paranoia, hunger for power, and, of course, violence complicating an already impossible challenge.

Secondly, the prospective outlooks in these works are very different. While *A Fall of Moondust* ends without a single casualty, in *Seveneres* only a little over a thousand people manage to escape Earth before the literal sky falls. And this number will only be dwindling because the state of technology Stephenson chose is just a smidgeon more advanced than what we have available today. There are no interplanetary vessels to be used

²⁹ Ibid., 30-31.

for evacuation, there is only a space station not unlike the present-day ISS.

Thirdly, Stephenson sometimes leaves even the readers' knowledge incomplete for specific purposes. Both Clarke's and Stephenson's works rely on knowing what would happen in some extreme circumstances, and this knowing is definitely used as a direct source of suspense. But, while the passengers of *Selene* do not know why they sank into the Sea of Thirst, Clarke explains to the readers that the fateful moonquake was a result of a millennia-long build-up of gas within the Moon. Stephenson, although very detailed in his technical descriptions, never actually reveals what had caused the Moon to break up:

What astronomers didn't know outweighed, by an almost infinite ratio, what they did. And for persons used to a more orderly system of knowledge, with everything on Wikipedia, this created a certain perception of incompetence, or at least failure to perform, on the part of the astronomical profession whenever weird things happened in the sky. Which was every day, actually. But most of them could be seen only by astronomers and so they were able to keep them a sort of trade secret.³⁰

Several theories on what was the Agent of Moon's destruction are proposed in the book, but none of them were confirmed or denied, or even paid much attention at all, mostly because the tatters of humanity had more pressing matters to attend to.

Lastly, it would be remiss not to mention a small detail from *Seveneves* that so fortuitously lines up with the introductory analysis that was performed at the beginning of this article. One of the major crises that happens in the book is precipitated by what will later be called "Tavistock's Mistake" by the survivors. Without spoiling much of the plot, it refers to the circumstances that an over-reliance and overexposure to media, in particu-

³⁰ Ibid., 22.

lar social media, can lead to unwelcome fomenting of paranoid sentiments and eventual fateful breakdowns of unity and communication. As was previously noted, this nearly paradoxical result is something that can be witnessed even today.

This admittedly highly selective description of Stephenson's book may have presented it as grim and dour. On the one hand, this is the result of the efforts made to avoid the spoiling of the book's plot, but, on the other hand, *Seveneves* can sometimes indeed be pessimistic. There are, thankfully, bright moments of love, self-sacrifice and cooperation that defies all odds. But overall, the tone of this work is markedly darker than the other two that were considered previously. And therein we can recognize an emerging pattern.

IV. Fact in fiction

The three works of science fiction about the Moon were created in different times, and between them, our knowledge about the Moon has steadily increased. What also increases between these works is the amount of pessimism in them. The plots are driven by escalatingly worse events: Duracoto was merely sold to the sailors, passengers of *Selene* were buried alive, and in *Seveneves* the whole world was ending. Even the results and prices that had to be paid are progressively more difficult. The correlation between these aspects certainly isn't the result of chance. But why is it that the more we know about something the worse images of future our imagination is able to conjure? Shouldn't we expect that our increased knowledge will supply us with reliable ways to avoid disaster? The answer may be very simple. Human existence depends on many different factors: air, water, food, shelter, and so on, and a lack of any of these may prove fatal. Human happiness depends on even more: absence of pain, joyous experiences, fulfilling relationships with others and a myriad of other individually valued factors such that missing them can lead into a deep pit of misery. And these conditions seem to be *sine qua non* — one can have all the food and air in the world and still die of thirst; happy memories of a painless past do not help much the person

who is enduring and excruciatingly painful illness. Considering all of this, we become aware there are only so many ways in which some given circumstances develop favourably for mankind and so many more ways in which they can develop badly. It is only to be expected that our increasing knowledge will, in time, reveal more potential hells than possible paradises.

The story of *Somnium* is so optimistic, it may even seem naive at times. It perfectly captures that sense of wonder and awe when manifold possibilities unfold in front of us for the very first time. Kepler was aware that we are only beginning to learn about the Moon. If we can predict its position in the firmament so precisely and for so many years in advance with nothing more than pen, paper, a telescope and clear skies, who is to say what wonders will be uncovered with more sophisticated means? This is the wide-eyed optimism of a new beginning and it is not limited to astronomy. Promises of a new scientific age are established all to well in the ideals of the Age of Enlightenment. And while human hardships were neither denied or ignored, the sight was set for the remote horizon of the far future, the distance of which tends to obscure the details that house many devils.

The perspective has changed once the direct experience of the Moon was no longer a dream of a distant future, but a looming eventuality. Once humanity was actively working on reaching the surface of the Moon, all those previously blurred details began to come into focus. The practical complexities of a lunar landing demand that our attention is focused on preventing as many disasters as possible, and the only way to do that is to be aware of them: avoiding a disaster unwittingly isn't a thing of good planning, but of sheer luck.

Thus the vision of knowledge in *A Fall of Moondust* slowly moves towards that which we can recognize as contemporary attitude, but still retains optimism of modernity. Photographs of lunar surface showed that the Moon *could* have vast stretches covered with ultra-fine dust. These areas *might* swallow an entire vessel in the right circumstances. The vessel in that case *would definitely* face problems due to overheating and lack of oxygen.

Finding the distressed vessel *would definitely* be a major challenge in these circumstances. Notice how the low probability was only tied up with the setup of the plot, whereas the events that followed are quite compelling. This reflects the nature of scientific knowledge in a rather veracious manner. Scientific knowledge is borne of hypotheses: as long as specific conditions are met, we can very reasonably predict many things in our world; the more these initial conditions diverge, the less reliable our knowledge might be, though it is never utterly useless. The more we know, the better we are at linking causes and effects, but, at the same time, we are also more aware of the limits of our knowing.

This change of perspective may at first seem like a narrowing, a focusing on means for immediate ends, much like Horkheimer claimed. However, the plot of *Seveneves* shows how this practical focus can be expanded once again. Unlike the lunar landings, lunar disintegration is not something that is being planned nor is it expected to happen anytime soon. Yet, on astronomical timescales, such an event isn't inconceivable. Going by sheer numbers, humanity is likely to one day witness the breakup of *a* moon somewhere in the cosmos, and there is a slim chance that it might be *the* Moon. Not only is the perspective once again wide, wider maybe than it has been before, the gravitas of the scenario in *Seveneves* is also increased. A tourist tragedy on the Moon would be sad for everybody, but the loss of the Moon would become an existential issue for all.

Stephenson's book also sheds light on another dimension of knowledge that wasn't covered by previously analysed works. Most of the drama in *Seveneves* happens in the shape of conflicts between the 1500 survivors aboard the ISS. In principle, this might seem odd, as every single one of these people share a common goal (individual and collective survival) – surely such a small group with such an essential mission would be able to arrive at a rational consensus about how to achieve that goal. What Stephenson shows well is that, sadly, even the unity required for survival may fracture under the strain of particular and isolated perspectives on how that unity is to be maintained

and which issues ought to be prioritized. There are no true malevolent villains in *Seveneres*, most characters do advocate for what they genuinely believe is the best course of action. Horkheimer would definitely interject: this is precisely the failing of subjective reason! However, we would like to propose here a far simpler explanation, which will be the culminating conclusion that we draw from this extensive analysis of these several works of science fiction.

Whenever an argument would come to a dramatic head in *Seveneres*, it was usually because one party would (often justifiably) perceive the plans of another party as fatally flawed and would be compelled to intervene in order to stop a disaster. For when the remnants of humanity are just over a thousand people all in one place, a previously moderate risks become existential. And the thing with existential risks is that they needn't even be likely to be significant.³¹ In other words, the end of the world may come in various shapes, and each of those may be individually unlikely, the world still only needs one of them to end. Our growing knowledge about the world also grows our knowledge about existential risks. Furthermore, the threat of some of those risks is or was very palpable in everyday life (irreversible climate change, nuclear apocalypse). Not only do we know how things can go *bad*, we are becoming more and more aware of how things can become *the absolute worst*.

Interestingly enough, the most prominent existential risks humanity faces fulfil the previously mentioned criteria for pessimistic consequences. Nanotechnologies and superintelligent artificial intelligences may seem outlandishly fictional, yet they top well-known conventional warfare in existential risk estimations.³² Self-culpability in all of these cases is easy to recognize,

³¹ Nick Bostrom, "Existential Risk Prevention as Global Priority," *Global Policy* 4, no. 1 (2013): 15-31.

³² Anders Sandberg, and Nick Bostrom, "Global Catastrophic Risk Survey," *Technical Report #2008-1* (Oxford: Future of Humanity Institute, 2008), 1. The existential risk from nanotechnologies is found, for example, in the possibility that self-replicating molecular machines run amok

as these are all technologies that humans may prospectively develop, but their contradictory nature is a bit more elusive, at least until we look into how world-ending technologies come about. Naturally, the initial motive for creating these technologies would be the betterment of humanity, but now that we are aware of the risks, surely the world would be unanimous in banning development of such perilous technologies. But the world is vast and not nearly compact enough to enforce such a measure, and new discoveries are quite like a gas: they can slip through tiniest cracks and once released, they are nearly impossible to be contained. Even if the majority of the world adheres to the decision to stop developing dangerous technologies, all it takes is one rogue nation, perhaps even one rogue laboratory to make these efforts futile. Knowing that, just like in the case of nuclear weapon proliferation, fewer actors would be willing to self-sabotage their own research capabilities when an unscrupulous competitor may be covertly or overtly exploiting that. Does this mean contemporary pessimism is completely justified? Are we the inevitable architects of our own demise?

Nick Bostrom calls this idea the *Technological completion conjecture*, and to it he retorts: “What matters is not only *whether* a technology is developed, but also *when* it is developed, by *whom*, and in *what context*.”³³ Even if we accept the supposition that risky technologies are inevitable (which is in no way guaranteed), there are still other measures humanity may undertake to at least lessen the existential risk. There may be other new technologies just around the corner that may significantly ameliorate these risks. For instance, the very same superintelligent AI is the best measure for reducing the existential risks from all other sources, as such intelligence would be capable of ar-

and convert all matter on Earth into copies of themselves (the “grey goo” scenario). The existential risk from superintelligent AIs may come in many different shapes and sizes, but it fundamentally boils down to the possibility that such an AI would be exceedingly competent at whatever it is doing, but its goals won’t necessarily align with our interests.

³³ Nick Bostrom, *Superintelligence* (Oxford: Oxford University Press, 2014), 282.

iving at solutions humans can't even think of. Who is to say even better solutions (that aren't existential risks themselves) can't be found? With our increased knowledge, we may know how things can go wrong and we may know that things can go very wrong, but we still cannot claim that we know absolutely everything.

The fact that the unfavourable outcome only needs to happen once does not entail that a favourable outcome is similarly concentrated in a single event. It is a rather morbid false dichotomy to posit that the impossibility of a completely care-free future necessarily commits us to a doomed one. A negative attitude has its uses, though. Being pessimistic, thinking about possible bad outcomes of certain situations and actions, can lead to more careful deliberation, perhaps even to taking steps to prevent the unwanted outcomes. With an overly optimistic attitude, one might overlook or underestimate important risks and thus create great problems in the future. A better future is theoretically possible, but it is in no way guaranteed. Great efforts must be made to reach it, and even then, it must be reached in a sustainable way, lest we risk having it slip through our collective fingers.

Naturally, an overly pessimistic attitude can be equally damaging, particularly if it escalates into paralysing fear or languishing despondency. As is the difference between a brooding teenager and a cautious adult, a right measure of pessimism can be an indication of the maturity of a society. In line with this metaphor, we conclude that perhaps this peculiar difference between the modern and contemporary sentiment towards knowledge, science and technology is a sign of our "growing up." Our first outlook at the possibilities of systematized knowledge was that of a wide-eyed child, eager and optimistic about the future. As we grew and as we learned more, we encountered more limitations and frustrations, which planted seeds of ill temper. Finally, now that we can envision the absolute worst-case scenarios, we have this adolescent tendency to dwell upon them – as well we should, provided that we ultimately decide on a course of

action; in other words, provided that we decide to grow up assertive. Yearning for the quaint days of innocence past may be soothing, but it cannot provide all the answers, as most genies will refuse to go back into the bottle.

The good news here is that we have already made first steps towards the new adult era of prudent planning and foresight. The probability of a nuclear apocalypse now may not be exactly zero, but it is definitely a lot lower than it was some fifty years ago, at the height of the Cold War. Not so long ago, acid rains were a major bugbear among environmental issues, and now this problem is considered to be “in many ways solved successfully.”³⁴ The bad news is, these are only the first steps, and some of the issues we have anticipated for so long are beginning to catch up with us. If we hope to grow up from our contemporary attitude, there is still plenty of work to be done. And just like it was for the survivors in *Seveneves*, chances are that things will become a lot worse before they start getting better.

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³⁴ Peringe Grennfelt, ed., *Acid Rain – Science and Policy Interactions over 50 Years* (Stockholm: Swedish Environmental Research institute, 2018), 17.

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