Spaceship or Stewardship: Imaginaries of Sustainability in the Information Age

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Abstract: *»please add abstract«.*
This paper contrasts two approaches to implementing the notoriously ambiguous ideal of sustainability: one driven by the centralized, managerial metaphor of Spaceship Earth, and the other by a notion of stewardship that foregrounds the values of care and obligation. Both approaches depend on infrastructures to enable them, but these are built on different combinations of the material, the social, and the moral. Viewing Earth as a spaceship amenable to human guidance and control makes sense only if we also accept the power of dominant "centers of calculation" that gather and disseminate standardized knowledge instrumentally to ensure global coordination. Stewardship, by contrast, relies on infrastructures of locally shared values and distributed innovation in human-nature relations rather than on universal scientific knowledge or technology. Stewardship is often propagated by social movements seeking to promote globally sustainable ecological practices. The two approaches have markedly different implications for designing future infrastructures to promote transformations to sustainability.

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Transformations to Sustainability

As more of humanity wakes up to the threat of climate change, talk of transformation is increasingly in the air. To survive, we are told, humanity must find ways to transform its relationship with nature and its own practices of consumption: that includes energy, food, water, housing, health care, waste management, and transport among others. In short, transformation must reach into all of modernity's intricate systems for keeping communities alive and economies humming. All of these carefully constructed infrastructures must be "changed, changed utterly," as surely as the poet William Butler Yeats saw rules of political engagement changing after Ireland's 1916 Easter Uprising. But are we prepared for such fundamental transformations, and what conceptual resources have we acquired to engineer the changes that have to happen?

Transformations, by definition, must run deep. The word implies thorough, dramatic, and radical change. Transformations cannot be merely cosmetic shifts in our modes of living. Business as usual is no longer an option, at least not if "usual" means the ways in which the rich of the Earth learned to live after the First Industrial Revolution. But how can one begin to undo so much that has become habitual and natural, worked into the deep infrastructures of industrial societies, let alone rethink the pathways forward? The COVID-19 pandemic was a prod to such reflection because so many supports of what we take to be normal living dissolved all of a sudden. Taken-

for-granted frameworks of sociality disappeared, like the office, the pub and the workplace. Even the essential infrastructure of caring for children yielded to the virus as schools were closed for months in many parts of the world and home schooling became the norm, not the exception. The pandemic forced us to think about the hybridity of infrastructures, not just as built environments, but as constructs in which the physical and the material are inseparable from the social and the moral. It is in that global experience of dissolution and recovery that this paper has its roots.

Beginning in the spring of 2020, together with Stephen Hilgartner of Cornell University, I initiated a 16-country comparison of policy responses to the pandemic (Jasanoff and Hilgartner 2022). It was a qualitative project, designed to address not only how countries were managing a public health crisis but on what grounds they justified their policies and with what consequences beyond keeping people healthy. In keeping with methodological preferences in Science and Technology Studies (STS), we looked not only at formal policy instruments but also at their implementation in practice. We collected images and videos and other non-traditional materials, as well as documents, as a basis for comparison. Specifically, in early months of the pandemic, we asked each national research team to send us illustrative pictures. A recurrent image from around the world was of empty highway interchanges that would normally have been packed with moving vehicles. Almost overnight, a vast material infrastructure was rendered almost irrelevant. Roads and highways remained intact; it was the human users who vanished. One could not have asked for a clearer demonstration that transformations of enormous ecological significance need not involve material changes at all. They can also be attained by changing how humans choose to use and live upon the Earth.

The skies themselves bore witness. From an ecological standpoint, the pandemic was a showstopper. For a few short months people marveled as pre-industrial nature returned. We stopped emitting airborne particles and blue skies appeared above cities normally shrouded in polluted murk. Birds sang in places where they had not been heard in living memory. Animals appeared in city streets, no longer having to compete with cars. Then the virus receded and life returned to normal, but we had gained a glimpse into an alternative future. Those real-life images of deserted highways showed us that there is nothing essential about the ways we have chosen to inhabit the Earth. A deadly virus can impose choices on an entire planetary population that under any other circumstances would have been unthinkable. The relationship between infrastructure and ecology is neither firm nor fixed but potentially malleable.

In this essay, I reflect on this aspect of the pandemic shock. The two words of my title, spaceship and stewardship, refer to two ways in which we can imagine the relationship between infrastructure and ecology if transformation is the mandate for humanity's future. These words, I want to suggest, do not refer to two distinct categories of things: the first about materiality (spaceship) and the second about norms (stewardship). Each comes equipped with an apparatus of sense-making that allows it to frame how we organize our material *and* moral thinking about the world. Unlike the traditional humanities, STS does not see words as living only in fields of discourse—as mere words, or as words in collaboration with symbolic representations that have nothing to do with reality. Instead, STS puts the products of our humanistic imaginations in full-blown conversation with the products of human creativity expressed in material and instrumental forms. This essay, then, is about the interlinked infrastructures of materiality and meaning-making and the normative stakes that we attach to our real and imagined ways of living on Earth.

Origin Stories of Sustainability: the Far and the Near

As a first step in the analysis, I would like to probe the origins of a word that, perhaps more than any others in contemporary ecological discourse, has sought to integrate our thoughts about human-nature interactions. That word is *sustainability*. One can trace a line of historical development that runs from the 1987 Brundtland Report, *Our Common Future* (Brundtland 1987), to the Sustainable Development Goals promulgated by the United Nations in 2015. And yet, although (or perhaps *because*) one can track the word through innumerable texts and analyses, its meaning remains contested, through ties to different histories and different conceptions of desirable futures.

One story line that many have embraced begins with what came to be called the Blue Marble, or the Pale Blue Dot (Sagan 1994), the first complete picture of Earth that came back from the Apollo missions launched by the United States from the late 1960s to the early 1970s. This was the perfect image of the planet as a whole that schoolchildren internalize when they first see a globe, not a partial Earthrise but Earth in the round, thinly veiled by a swirl of clouds but still luminous against the darkness of space. The cloud formations were sparse enough to let us to read the outlines of continents, Africa in particular and the lower part of the Arabian Peninsula. Not surprisingly then, of all of NASA's enormous store of pictures, this is the one that became the iconic planetary image, endlessly reproduced as a signifier of rising environmental consciousness.

In the North, this particular image of the Pale Blue Dot had a transforming effect on environmentalists' imaginations. The Brundtland Commission invoked it in the opening paragraph of its famous report:

> In the middle of the 20th century, we saw our planet from space for the first time. Historians may eventually find that this vision had a greater impact on thought than did the Copernican revolution of the 16th century, which upset the human self-image by revealing that the Earth is not the centre of the universe (Brundtland 1987, "A Call to Action").

The finiteness of a planet magically suspended in space spurred thoughts about resource limitations and prompted a definition of "sustainable development"—development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This idea has become almost banal in the talk and thinking of environmentalists and indeed anyone who stands to gain from instrumentalizing the environment for professional, political or economic gain. In North America, as one might have predicted, the image circulated widely, appearing in all sorts of commercial as well as political and educational settings. On a hotel pillow in Washington, DC once, I found a small card saying, "Think twice before you ask for your sheets to be laundered." The background was the image of the Blue Marble.

It soon emerged, however, that although the image stood for the globe, its uptake was by no means global. At the turn of the millennium, in December and January of 1999-2000, I looked for images of Earth from space during a tour of India from Kolkata in the east to Mumbai in the

west and Delhi in the north to Hyderabad toward the south. The Blue Marble, defined against a deep black background, ubiquitous in America, was almost nowhere to be seen in India. I found only one instance, and that in an unlikely venue: an advertisement for an IT center in Kolkata many floors up on the side of an anonymous office block. Earth images did mark the millennium in India, but they were typically pictures of the globe, sometimes held in human hands, and other times simplified into circles with longitude and latitude lines drawn upon them. To me this discrepancy said something important about the role of infrastructures in conditioning our environmental imaginations: that the instruments with which we inform our vision feed back upon our definition of the nature, scale and scope of environmental problems.

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In India at the millennium sustainability was more often signified through an altogether different image, attached to a different storyline, one that had (at that time) no exact counterparts in the West. This was a picture of parched and cracked earth, often with a seated human figure seemingly waiting for rain. As prevalent as the globe mentioned above, this image spoke not of a distanced, planetary outlook on sustainability but one grounded in soil and place. People were waiting for rain here and now, for nature's beneficence, not for some abstract solutions handed down from above by expert knowledge. In villages across the subcontinent, water, food and energy were all sourced close to home, and sustainability followed the rhythms of the seasons. Cow dung patties drying on a hot roof spoke to an infrastructure of localized sufficiency, with household energy and animal husbandry forming a tight-knit technological package, independent of extended supply chains. These domestic fuels may be polluting, like the farming practices that burn down fields of stubble and render New Delhi's air unbreathable in the months after the harvest, but their effects are immediate and palpable. Nuclear power plants, by contrast, look orderly, clean, and contained, emitting no airborne carbon. But their contribution to climate sustainability rests to some degree on an erasure of underlying human and social networks: the labor of uranium miners (Hecht 2014), the above-ground wastes stored at distributed sites, the contaminated topsoil bags from Fukushima, and the potential leaks between civilian and military uses of nuclear materials (Jasanoff and Kim 2009).

Normative Underpinnings: STS and Co-Production

What does it mean to think about sustainability in futuristic terms when so much that conditions environmental behavior already seems fixed and laid down? Engineers typically think about sustainability *before* a structure gets built. No one wants a bridge to fall down, a building to be ravaged by fire, or a street to produce a lethal crush of people. Yet, once things are built, whether a London pedestrian bridge that sways unexpectedly to the march of many feet or a popular tourist street in Seoul tragically ill-equipped for holiday crowding, the future seems constrained into inevitability by past choices, The future of the planet, however, is not yet determinate, not yet completely ordained. How then do we project thoughts of sustainability wisely into our uncertain, indeterminate future?

The idea of co-production in STS offers a starting point. Co-production has multiple meanings in environmental discourse, but in STS it means something quite specific (Jasanoff 2004)). It means a blurring or even a denial of the boundary between *is* and *ought*, between what we take to be the state of the world and how we wish to live in it. A foundational feature of Enlightenment thought is that the reliability of our characterizations of the world derives from science and the

legitimacy of our normative choices from moral philosophy. The *is* and the *ought* thus inhabit different spheres of meaning and understanding, each constrained by its own principles and practices of reasoning. Co-production challenges this simple binary and problematizes it in ways that are especially germane to environmental thinking, including the design of infrastructures that promote closer integration between nature and society.

The worlds we bring into being through scientific knowledge and through material manipulations are also worlds that we, in some sense, value, want to interact with, and live in. Dreams of flight, for example, far predated the actual invention of flying machines. People looked at birds, freely circling in air, and imagined how liberating it would be for human beings to leave the Earth and take flight. Visionaries kept dreaming and experimenting with becoming airborne—whether the mythic Daedalus, the polymath Leonardo, or the pragmatic, engineering Wright Brothers—until, ultimately, flight became a reality for vast numbers of ordinary people.

Co-production like any good analytic concept works only if it can be operationalized and applied to the matter of the world. There are, to begin with, identifiable moments in the dynamics of any society when we can see co-production happening: at moments of emergence, when something new and valuable appears in the world; in episodes of controversy between competing ideas of desirable ends; in times of translation, when ideas get carried from one place to another; in processes of standardization, when people iron out frictions in the definitions of terms or the meanings accorded to them; and in places of convergence, when different cultures imitate or adopt each other's products and productions. At such moments, divergent ethical assumptions come into view, while actors sort out which forms of living they wish to collectively pursue.

Further analytic purchase can be gained by examining the mechanisms by which a co-produced state of the world becomes stable. These are moments when science and technology often appear in full force, producing representations of how the world works: climate change is one salient example. New discourses often emerge to characterize society's choices (e.g., mitigation and adaptation in response to climate change), people's identities and subjectivities are reshaped in accordance with new self-understandings or knowledge of the world (e.g., climate denialists), and new institutions come into being to govern the altered world (e.g., the Intergovernmental Panel on Climate Change). Infrastructures are the material manifestation of co-produced worlds in which these constitutive elements of society (representations, discourses, identities, institutions) emerge and are durably bound together.

Sociotechnical Imaginaries

If co-production offers a theory of stabilization, then how do societies change, let alone transform themselves? This is where the STS idea of sociotechnical imaginaries offers a further handhold. In a co-edited volume, *Dreamscapes of Modernity*, Sang-Hyun Kim and I defined sociotechnical imaginaries as follows:

> Collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology (Jasanoff and Kim 2015, p. 4) .

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Our argument that societal responses to technology correspond to shared imaginations of the collective good derived in part from cross-national comparative research on environmental

movements and policies. That research has proved especially fruitful in showing that societies at varied organizational scales, including but not limited to nation states, are capable of articulating and realizing very different futures when they confront the same technological choices.

Thus, the reception of nuclear power has varied widely across Germany, South Korea, and the United States. To explain why, one needs to ask what is the good seen to be achieved and the harm to be avoided in each national setting, as well as to understand the political pathways by which such aims are realized. Historically, Germans were most worried by the prospect of catastrophic risks against which the state could not offer adequate protection, whereas South Koreans wanted to ramp up their energy supply so they could develop as a nation and catch up with perceived forerunners in technological progress. In the United States, by contrast, citizens were most troubled by potential risks to life and health, and the unequal distribution of the benefits and risks of nuclear waste disposal. These differences in underlying national imaginaries led to an active social movement against, and a de facto ban on, nuclear power in Germany, a tacit moratorium in the United States following the Three Mile Island accident, and continued reliance on nuclear power despite pockets of opposition in South Korea. In sum, it was not expert opinion on nuclear safety and risk, but powerful societal imaginations of desirable and attainable futures that most significantly influenced technological infrastructures in each country.

The imaginaries framework does explanatory, historical work in accounting for such variations, but it also offers a productive way of thinking about transformation and social change because it directs us toward seeing the future as a space of politics and choice that can be made normative, collective, tractable and accountable, in short, governable. The future is worth fighting for precisely because winners and losers are not yet known; and technological infrastructures matter because they help some collective desires to realize themselves and achieve stability while others are set aside as too difficult or abandoned.

Struggles over the future are not limited to competition among nation states. For instance, when indigenous populations around the Arctic mobilized, like canaries in a coal mine, around a shared perception of extreme vulnerability to climate change, we saw an emerging political identity ready to advocate for a particular kind of future without the traditional supports of shared nationhood. Prominent among the demands of such groups and movements is an explicit recognition of locally grounded knowledge and understanding of the environment that may not be picked up in the work of international expert bodies.[1] STS inquiry leads us to ask how such previously inchoate groups, collectives lacking standard means of exercising voice such as voting rights, can nevertheless make futures seem tractable and accountable. That inquiry invites us to explore how science and technology provide epistemic and material infrastructures upon which assenting or resistant political projects are built.

Infrastructures of Displacement

In our uniquely visual age, what one sees from any standpoint can easily be memorialized and instantly transmitted worldwide. As members of a global polity, we have in effect become each other's witnesses. The vocabulary of politics therefore has to make room for the use of images.

[1] See, for example, Arctic Council, Indigenous People's Secretariat, https://www.arctic-council.org/about/indigenous-peoples-secretariat/ (accessed December 2022).

They tell us how people see themselves and the world around them, and they convey information about standpoints that would not easily be available from other sources. Politics and social theory both teach us that standpoint matters to the crafting of agendas and purposes. One may look to images, then, to discern more clearly how infrastructures that already exist in the world relate to possible ecological futures. What will need to be transformed or remade to build more sustainable futures?

A disconnect exists between the lived experiences of people harmed, displaced or killed by the fury of a changing climate and the ubiquitous charts and graphs by which we have come to know climate change, from the famed Keeling Curve[2] showing increases in atmospheric CO_2 concentrations since 1950s to the much-disputed hockey stick graph[3] of global mean temperature increases in the past thousand years. Figures that show us such highly aggregated measures of varied parameters of climate change do not tell us much about how impacts will affect specific populations and still less about the infrastructures in place to protect them when catastrophe hits. As the lethal European floods of 2021 made clear, people can be caught unawares even in one of the most modernized and ecologically conscious countries in the world. Chancellor Angela Merkel declared at the time that "The German language can barely describe the devastation." A hydrologist at the University of Reading in the United Kingdom commented: "We should not be seeing this number of people dying in 2021 from floods. It just should not be happening" (Cornwall 2021, 372). Yet armed with masses of data and powerful charts and graphs, we think we are in control, we understand the drivers of climate change, and we can calculate the limits below which Earth and its inhabitants will maintain sustainable lives.

Scientific and technological representations of complex environmental phenomena often gain their predictive power by erasing the experiential details of where and how people are actually living. These erasures may result in surprises such as the European floods of 2021, but discrepancies between societies can also be erased, with grave implications for social justice. The cover image of one of the most important reports on sustainability from the end of the twentieth century makes this point. India's Center for Science and Environment (CSE), led by the late Anil Agarwal and Sunita Narain (1991), produced a short but provocative report entitled *Global Warming in an Unequal World*. Grounded in a tacit vision of co-production, the report presented a radical challenge to the ideas of sustainability that were emerging in the Global North. Briefly, the report argued that all atmospheric carbon molecules should not be counted as equally objectionable from the standpoint of climate mitigation. Rather, the "luxury" emissions of the rich should be accounted as more damaging than the "subsistence" emissions of the poor. In the context of this essay, we might restate their proposition to say that Agarwal and Narain asked for greenhouse gas emissions to be penalized in keeping with the infrastructures that produced them. The grounded, close-to-home, and modest emissions of poor people leading hard-scrabble lives should not be weighed on the same scale, they argued, as emissions generated through the carbon-intensive lives of the rich.

The report's cover featured the "Yo! Amigo!!" cartoon, which has since become a canonical text in environmental justice. A well-fed, ostentatiously shirted, obviously American driver, belching

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[2] The Keeling Curve, University of California San Diego, Scripps Institution of Oceanography, https://keelingcurve.ucsd.edu/ (Accessed December 2, 2022).
[3] Hockey Stick Graph, Wikipedia, https://en.wikipedia.org/wiki/Hockey_stick_graph (Accessed December 2, 2022).

fumes from the back of his pickup-truck, admonishes a scrawny, impoverished man with an ax, "We need that tree to protect us from the greenhouse effect!" The same piece of nature - a tree - sustains two diametrically opposed political economies, posing existential challenges to both. In the economy of the poor, it is part of the basic infrastructure for subsistence, whereas for the rich it merely offsets the reckless burning of fossil fuel to serve the transportation whims of the wealthy car owner. Weaponizing humor, the cartoon questions whether a natural object can be accorded universal meaning and value in relation to climate policy when it serves such distinct socioeconomic functions. Once again we see that infrastructures are co-produced, with their material elements making sense only in relation to underlying normative commitments about what constitutes right or beneficial ways of living.

Infrastructures of Knowledge: CSE and WRI

We are now in a position to return to the framing visions of spaceship and stewardship with which I began this essay. The work that was being done by the Center for Science and Environment, work that eventually gave rise to its global warming report, serves as a good place to start. In 1982, CSE issued its pathbreaking work, *The State of India's Environment, the First Citizens' Report* (CSE 1982). Its purpose was to compile field notes from all over India of ways in which changes in the environment were having an impact on people's lives, particularly the poor, who as we have seen are most dependent on their immediate environment to meet their basic needs. The contributors were not experts but witnesses. They gave testimonies based on their personal experiences of environmental degradation

In Washington, DC, in the same year, the World Resources Institute (WRI), an American think tank, also launched a project to collect data on the environment.[4] WRI's founders said they saw a need for an independent and credible institution, not an activist membership organization, to provide data for international policy making, particularly in relation to population and development goals. Research and analysis, WRI declared, must be both scientifically sound and politically practical.

The two projects could not have been more different in framing and intent. Where CSE wished to give voice to the lives of individuals, particularly the poor, WRI highlighted populations, or aggregates of people, and the abstraction of development. Data were detached from particular identities and representations in an effort to be "scientifically sound." WRI's knowledge claimed to be universal, appropriating the impersonal, placeless authority of science and technology.

Table 1: Politics of Knowing at CSE and WRI

CSI	WRI
• Focus on India	• Focus on world
• Citizens' report off-setting the state	• Agenda setting for international action
• No outside grants	• $15 million foundation grant
• Voluntary organizations	• Expert analysts

[4] For a brief history, see World Resources Institute, Our History: 40 Years of Impact, https://www.wri.org/about/history (Accessed December 2, 2022).

• Testimony	• Assessment
• Values: self-reliant, non-hierarchical, non-sexist	• Values: integrity, innovation, urgency, independence, respect

Between them, these two projects show how the imaginary of ecological stewardship differs from that Spaceship Earth. CSE explicitly limited its gaze to India, and within the nation state it sought to democratize knowledge by suggesting that the state had not been adequately supportive of citizens' interests through its own data gathering processes. This was a *citizens'* report, compiled by social activists from the bottom up. CSE stressed that it did not accept outside grants, that its work was entirely voluntary, and that its strength derived from the unmediated authenticity of the people's voice. WRI, by contrast, focused on the world and it allowed international organizations and foundations to fund its project. Whereas CSE relied on voluntary organizations to supply data, WRI looked to expert analysts. And, although both organizations were co-productionist in the sense that they embedded their knowledge within a framework of values, the values themselves were markedly different. CSE's embrace of self-reliant, nonhierarchical, and nonsexist values was consistent with the posture of social movements, whereas WRI's values of independence, integrity, urgency, and respect were more consistent with norms of scientific inquiry that place its adherents above any possible political fray.

Centers of Calculation

The moves that the World Resources Institute made to establish its authority were recognized in one of the late Bruno Latour's foundational writings, a 1990 article called "Drawing Things Together" (Latour 1990). In it, he talks about the ways in which an expert organization such as the WRI acquires epistemic authority. The crux is the creation of an infrastructure that is capable of receiving, processing and disseminating knowledge by eliminating traces of personal or subjective origins. WRI is in Latour's terms a prototypical "center of calculation," a term that has acquired wide standing in Science and Technology Studies. But here I would like to call attention to the fact that a center of calculation itself depends on infrastructures of authorization that one may wish to problematize and place under a critical lens.

In the article, Latour describes the French adventurer-explorer Jean François de Galaup, comte de Lapérouse who goes on an imperial mission for Louis XIV, the Sun King, with the express mission of bringing back a better map of the Pacific region. Latour narrates the story as a fable. One day Lapérouse lands on an island. He meets with the local Chinese and tries to learn from them. They know their own geography quite well and somebody draws a map in the sand. A younger lad picks up one of Lapérouse's notebooks and draws the map again with a pencil, and here is Latour's origin myth of science. It is the art of making inscriptions, representations that are flat and portable and movable so that something can be taken back and the voyage of disco very is not wasted. This, Latour says, is the difference between the "savage geography" and the "civilized" one. The former stays in place, as if drawn in the sand, locked in the minds of those who know but have not the art to represent in instrumental ways. Science only happens when that map then gets back to Paris, which becomes the center of calculation, disseminating the knowledge outward into the empire of Enlightenment. This is very much the WRI's modus operandi. It is how we laypeople get to know the planet, how we know sustainability, and figure out what instruments we need to achieve that goal.

Lapérouse's map, again in Latour's evocative terms, is mobile, but it is also immutable, presentable, readable and combinable. These are the attributes of scientific inscriptions that allow us to extract knowledge from experience, and re-represent phenomena in ways that then become powerful infrastructures for future work. And of course it is not merely the machinery of representation that science has developed but also, with the computer revolution, increasingly sophisticated instruments of reading, processing, and interpretation.

The legacy of Lapérouse, at least as imagined by Latour, found its latter-day embodiment in the Buckminster Fuller, the American architect, designer, systems theorist and prime prophet of the spaceship imaginary (Fuller 1969). In a graphic celebrating Earth Day 2018, the Buckminster Fuller Institute that bears his name juxtaposes that original Blue Marble with what happens when we turn Earth into a latticed field reminiscent of another Fuller invention, the geodesic dome.[5] The entire physical planet becomes an abstraction, a field of data, rendered calculable, mobile, and portable. This vision has become so powerful that it merges the seer and the seen, is the observer from on high surveying Earth in the totality of its systems. Indeed, one may perceive in the rise of the concept of the Anthropocene, a term that refuses to separate human activities from nature's dynamics, a further development of the spaceship imaginary in which humans are no longer at the helm, guiding its voyage, but blended into the planet's infrastructure, part of the spaceship's workings and its eventual fate.

Loving Our Monsters or Taming Them?

If we have not only turned the planet into a vast infrastructure for life, but ourselves into cogs in that machine, then at the very least, we should love our technological monsters, so Latour urged. Otherwise the fear of catastrophe might overwhelm us. We can fold human purposes into the molecular machinery of soil bacteria through our sciences and technologies, we can run robots on Mars, we can photograph the galaxies, and yet we fear that the climate could destroy us. The solution is to embrace the transformations, and learn to be at one with the mechanical world we have made. But less comforting visions persist, in which integration and harmony are overtaken by loss of control as the price of technological hubris. Ulrich Beck, renowned author of *Risk Society* (Beck 1992), held that the Anthropocene is not necessarily a place where humans are or can be in control. In a short but illuminating essay called "Anthropological Shock," prefiguring his later thought, Beck (1987) suggested that we are no longer sovereign in our own terrain because we have lost the sensory capacity to know for ourselves what risks lie around and ahead. We do not enjoy meaningful understanding of how to live if we need experts to reassure us at every turn whether it is safe to eat, drink, go outdoors, or let our children play in sandboxes. In response to the techno-optimistic vision of a future in which the union of human and machine will become progressively more powerful, Beck offered a more gloomy projection of a future that has outstripped our ability to know it, let alone to make it tractable to human wishes. And Beck died five years before the COVID-19 pandemic, which demonstrated the futility of preparedness as cultivated by rich nations confident of their foresight and power to control.

Beck and Latour embraced radically different assessments of the infrastructures humanity has built for sustenance and support, but both articulated them as if these structures *are* the future, a

[5] https://www.bfi.org/2018/03/27/spaceship-earth-day/ (Accessed December 2, 2022).

future dependent on technology's shaping of life's possibilities. Yet this posture of technological determinism has long since been rejected by historians and STS scholars. Why does it nonetheless retain such power to convince, and how else might we contemplate the human-nonhuman relationship other than in terms of machine-driven control and domination?

A striking feature of the way that these theorists imagine the human-nature relationship is the scale of their perspectives. The "we" of their contemplation is the universal human, operating on an Earth taken as a whole, seemingly devoid of history and particularity, A telling consequence is that "solutions" to the climate problem, driven by such "whole Earth" imaginations, also have tended to be conceptualized on a planetary scale. Nowhere is that imaginary more apparent than in the enthusiasm for solar geoengineering that animated scientists in the Global North at the turn of the century and continues today. The anthropologist Joseph Masco (2015) points out, in effect, that geoengineering itself involves a massive act of imagined control. Programs for carbon capture on a global scale compete with proposals to shift the chemical composition of the atmosphere. These changes are as yet speculative, extrapolated from natural phenomena such as volcanic eruptions that occurred more locally. We do not know what the consequences of these projected forays into the future will bring, only that the grandness of the ambition has proved powerfully seductive.

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It is not far-fetched to trace a genealogy of influence from the Apollo image of the Blue Marble through the data gathering of a World Resources Institute to the theorizing that led to the idea of centers of calculation and the Anthropocene—and from there to plans for deflecting solar radiation as it travels to Earth's surface. Geoengineering is conceived as an intentional global manipulation to save the planet from unintentional interventions launched across previous centuries of economic growth, especially since the Industrial Revolution. Borne on the authority of a science assumed to be invincible, this savior technology has gained ground in our collective imaginations partly through the work of centers of calculation. But is this the only way in which transformative responses to climate change can achieve global buy-in?

An important strand of STS theorizing tells us that we should be symmetrical with regard to explanations, more specifically, that we should not only look at the dynamics of science in considering what futures are possible, but equally at moves originating elsewhere in society. Scientific knowledge travels, Latour tells us, through acts of representing, abstracting, making portable, bringing the results back to the center and then rediffusing them. But can knowledge originating in society also travel and diffuse? The work of India's Center for Science and Environment exemplifies a very different form of diffusion, a diffusion through normative channels and not primarily through the epistemic and material.

The *First Citizens' Report* that CSE issued was so amateurishly put together that, upon being opened, its first page appears upside down. The language was English, and whoever glued the inner pages into the book's binding quite possibly did not know how to read the text or ensure its correct orientation. It was a cottage industry product, and a bookbinding error was par for the course. Crucially, though, what CSE launched with this homely publication was a way of knowing for a nation, through the witnessing eyes of dispersed local groups. Such knowledge from below did not necessitate any abstractions or centers of calculation, but it too proved fit to travel.

The Chipko movement originating in northern India in the 1970s offers a well-known example of environmental consciousness disseminating with little need for complex infrastructures or expert inscriptions. In America, "tree-hugging" became a derogatory term for environmentalism, standing for unreasoning emotionalism and nativist attachment to landscape. But in its origins the term carried a different normative weight and was transformative in its way. The movement's organizers used the simple act of people ringing their arms around tree trunks to prevent inroads by modern development that began with chopping down trees. The symbolic union between humans and their habitat proved to be highly persuasive and Chipko became an iconic example of how to mobilize home-grown values to prevent foreign capital from degrading poor forest dwellers' habitats. Built on the principle of stewardship, the movement demonstrated with the choreography of human bodies that that the most effective way to care for nature may be through direct action, even if it means risking violence and death to do so, and that message also carried around the world.

Precaution and the Politics of Future Making

Stewardship animates the notion of precaution, a normative principle that has been widely taken up in environmental law and policy. Usually traced back to the *Vorsorgeprinzip*, a cornerstone of German environmentalism, precaution was written into the 1992 Rio Declaration, the Maastricht Treaty of the European Union (EU), and spelled out in detail in the EU's millennial Communication on the Precautionary Principle in 2000.[6] As articulated in that last source, the precautionary principle applies "where scientific evidence is insufficient, inconclusive or uncertain and there are indications through preliminary objective scientific evaluation that … the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the chosen level of protection." Precaution needs to be proportional, nondiscriminatory, and consistent, based on weighing potential benefits and costs, and hence is accountable to reason without being held hostage to demands for definitive scientific proof of harm. At the same time, it allows for knowledge to develop, and indeed some laws call for research to be undertaken if the principle is invoked to block development.

The EU Communication of 2000 can be seen as articulating an imaginary of rightful technological intervention. Before disrupting the environmental status quo, one should ensure that knowledge is sufficient to justify confidence, and alternatives are to be weighed before steaming ahead. This idea of restraint in the face of uncertainty was incorporated into the French Constitution in 2005 and in the constitutional law of a number of other countries since then. US environmental policy, on its face, prefers risk assessment to precaution. Yet, the first major piece of relevant American legislation, the National Environmental Policy Act (NEPA) of 1969, was written in the same spirit. NEPA instructs the federal government to conduct an assessment and prepare an environmental impact statement for every major federal action significantly affecting the quality of the human environment. That too is a precautionary move, and as in the European version it calls for alternatives to be considered before significantly altering the infrastructure of human lives. NEPA also mandates public consultation so that non-expert positions, and their ways for caring for nature, receive a respectful hearing.

[6] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52000DC0001 (Accessed December 2, 2022).

Spaceship or Stewardship?

I turn in conclusion to a site where two different imaginations of sustainability have come into contact in an infrastructural project that has changed the ecology of an entire region: that of the spaceship, articulated through universal criteria of sustainability, and that of stewardship, foregrounding concern for those whose lives will be affected, who wins or loses, and who is responsible for the costs of transformation.

Pavagada Solar Park, which I visited in early 2020, was billed at the time as India's second largest solar development, built in the vicinity of Bengaluru. A solar park capitalizes on using the renewable resource of solar radiation as the infrastructure of sustainability, in place of nonrenewable and polluting fossil fuels. The expanse of grey-blue solar panels at the site looks like a digitally rendered ocean stretching into the distance, but on closer contact it is the dustiness of the surface that draws attention. Pavagada was constructed in a very dry part of India, where water is constantly needed to keep the panel surfaces clean. Is that water supply as reliably renewable as the energy the panels capture from the sun? The visual evidence on the day of our visit also complicated the claim of India's growing energy self-sufficiency. Chinese packing crates were still lying around, reminding the observer that the renewability of solar energy depends on supply chains that are themselves subject to geopolitical disruption, rendering the system anything but self-contained and free from friction.

The guard who let us in told an interesting story. He and his brother had been farmers on that land and together they had owned a substantial chunk of property. It was profitable to them to rent it out to the solar park owners with a steady income coming back over the next 25 years. He was getting more money, with greater certainty, than he had got from farming. So he was happy to switch jobs and become a caretaker, dressed in office uniform, a representative now of the entity that runs the park. A key factor in his decision making was that he and his brother between them owned enough land that the amount of rental income they got back was higher than what they were getting through farming. His story, it emerged, was not every farmer's.

We drove on and came to a nearby village where people started complaining to the members of our group and asked, "Why did you come to visit? Look what you've done to our communities." They no longer had work for themselves, nor prospects for their children. All of the farms in the locality had been taken over by the solar park and there were no jobs available, including for the young people, because the nearest big city, Bengaluru, was a hundred miles away and the transportation was not good. And so the immediate aftermath of installing renewability in physical and engineering terms was the non-renewability of local cultures that had subsisted on that land from time immemorial. The villagers, however, became extremely friendly when they learned we had nothing to do with the Pavagada project and insisted that we stay there for coffee before we drove back to the city. So there were ancient and renewable forms of sociality that we strangers almost accidentally fell into, but that left me wondering whether the infrastructures of the energy transition would lead in the long run to societies that are equally capable of self-renewal.

What then should we care to sustain? My Pavagada experience put two different ideas of renewables side by side. Is it cultural renewal, the renewal of a society as it has lived from as far

back as people can remember? Or is it the material renewability of the sun converted into energy for the use of distant consumers who will never see the place that captures the sun? And if we turn to the stewardship of Spaceship Earth, what are the forms of life that we should be caring for, the monstrous array of panels that absorb anergy from the sun or the ties between humans and nature that the spaceship imagination of a solar park literally bulldozes over?

Nature on its own has a modesty and capacity for regeneration not found in ambitious human constructs—not in a Pavagada Solar Park that seeks to harness the sun at a scale that dwarfs ordinary human enterprise. Stewardship of nature then suggests a need for a similarly ecological approach to transformation. Much of human history on the Earth, after all, has been about sustainability in the day-to-day sense of the term, not in giant leaps forward but adapting as we go along. Such stewardship is also modest. It is incremental, occurring in small doses. It is provisional because no permanent commitments are made nor promised. It is skeptical, never certain what the outcome will be. It is experimental, like pragmatist philosophy, committed to trying something out and assessing what happens. It acknowledges that what we are trying to achieve by transforming modernity's problematic infrastructures is not a technological silver bullet with which we will subdue climate change once and for all.

And the politics of stewardship can be inclusive, a collective imagination of futures open to laypeople as well as experts. This is what India's CSE has attempted to do with its successive citizens' reports, creating a composite picture of a nation's needs by drawing people (not *things*) together, by incorporating many voices, not through the science of centers of calculation nor the abstractions and representations of experts. Finally, stewardship carries with it an idea of learning -- not from the disasters that have often accompanied our more grandiose infrastructural visions, but from the daily, lived experimentation of building on what now is to imagine what is going to become.

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