Habitable Planet, 2026, 2(2), 432–447

Habitable Planet

Journal Homepage: https://www.sciltp.com/journals/hp

Editorial

Panbiotic Ethics as an Evolutionary Adaptation of a Habitable Planet in a Habitable Universe

Alexander D. Shenderov

Independent researcher, Lusby, MD 20657, USA; alexshenderov@gmail.com

ABSTRACT

The evolutionary concept of survival of the fittest is applied to civilization-building species and their prevalent ethical paradigm. Continuation of consciousness (sufficiently advanced to concern itself with ethics) is applied as an evaluation criterion for metaethics frameworks, normative ethics models and applied ethics practice. In particular, assertive panbiotic ethics of terrestrial guardianship and extraterrestrial gardening is likely advantageous to the fitness of a civilization-forming species choosing this paradigm—as well as that of the species' home biosphere, and potentially even its home Universe. The only biospheres—and Universes—that can get a deliberate reproductive boost are the ones that evolve civilizations able and willing to provide it. Civilizations that can, and choose to, protect and replicate their systems of origin appear likely to give these systems (including themselves) a decisive evolutionary advantage. Developing and using these abilities depend on the civilization's prevalent ethics. Evolving advanced civilization-forming consciousnesses deliberately helping their systems of origin immortalize themselves (through maintenance and reproduction) therefore appears to be a natural selection condition for these systems. This broad outlook appears highly relevant to humanity's ongoing challenges. Accepting such an assertive panbiotic ethical paradigm may help avert the energy crisis (and ensuing collapse of the global civilization) by enabling the transition to renewable energy while we still have the energy from fossil fuels to invest in it. Adoption of panbiotic ethics appears to be a selection criterion for civilizations to develop beyond planetary stage (that human civilization currently is at) and eventually help spread life beyond their home planet.

ARTICLE INFO

History:

Received: 01 March 2026
Revised: 27 July 2026
Accepted: 04 August 2026
Published: 11 August 2026

Keywords:

ethics as evolutionary adaptation;
assertive panbiotic ethics;
ethics of sustainable development;
evolution of intent;
cosmological natural selection for ethics;
ethics of panspermia

Citation:

Shenderov, A.D. Panbiotic Ethics as an Evolutionary Adaptation of a Habitable Planet in a Habitable Universe. *Habitable Planet* **2026**, *2*(2), 432–447. https://doi.org/10.63335/j.hp.2026.0047

Research Highlights

- The foundational Hume's law of metaethics is shown to be a fallacy.
- An alternative metaethics framework is proposed: ethics as an evolutionary adaptation.
- Panbiotic ethics of terrestrial guardianship and extraterrestrial gardening is hypothesized to provide an evolutionary advantage to the species choosing this paradigm, its home biosphere, and potentially even its home Universe.
- Normative and applied ethics derived from this evolutionary framework can provide practical resource-allocation guidance relevant to current global challenges (examples included).

1. Hume's Fallacy

In 1740, David Hume completed "Of Morals": the third book of his "Treatise on Human Nature". In it, he attempted to address the is-ought problem: the relationship between descriptive statements ("is") and prescriptive ones ("ought"). His views have since been dubbed "Hume's law" or even "Hume's guillotine", and taken to mean that one can't infer ethical conclusions from factual statements. What else can you derive ethical conclusions from, if not facts?

Hume's original position was literally this [1]: "as this *ought*, or *ought not*, expresses some new relation or affirmation, it's necessary that it should be observed and explained; and at the same time that a reason should be given, for what seems altogether inconceivable, how this new relation can be a deduction from others, which are entirely different from it". Yet "should be observed and explained" is a prescriptive ("ought") statement that Hume attempts to derive from descriptive one ("is": "expresses some new relation or affirmation")—in violation of the very prescription he is seeking to justify. Hume's Guillotine does not survive Hume's Guillotine. This argument is a fallacy according to itself.

The fallacy exists on several levels. The most obvious one is seeking to prove a negative: non-existence of a way to derive prescriptive statements from descriptive ones. Accordingly, Hume delegates defining what he meant by "new relation can be a deduction from others" to his unnamed opponents, whom he challenges to give a "reason". It is not clear what exactly "a reason should be given "for. Hume might be arguing that descriptive statements are insufficient to deduce prescriptive ones—or, instead, that they are unnecessary to do so. The descriptive statements in question could include all possible descriptive statements—the entire state of the world for all eternity—or some fraction of that. The fraction could be, for example, every fact available to the person making a decision in question at the moment (s)he makes that decision. Alternatively, it could be everything (s)he, at that moment, considers relevant to the decision being made. It is equally uncertain how that moment is supposed to be selected—even though its selection appears to be relevant to the descriptive statement set in question.

Without these specifics, Hume's "law" is too vague to serve as a metaethics basis for normative and applied ethics. Consider, for example, the following thought experiment: a hypothetical manuscript submitted to an academic journal presents a completely unconvincing critique of Hume's "law". Yet according to the "law", the conclusion that the paper "ought" to be, for example, rejected cannot be deduced from what its flawed content "is". At the same time, according to the "law", the prescriptive statement that the "law", or any other principle, "ought" to be observed cannot be derived from the descriptive statement that this principle "is", at least in the opinion of those choosing to observe it, valid.

This absurd situation is a radical departure from the history of ethics: the earliest known treatise on ethics, the Maxims of Ptahhotep, written about 4400 years ago, shows that Ptahhotep already recognized metaethics as the basis for solving real-world moral questions. Both Aristotle in the Western philosophical tradition and Confucius in the Eastern one supported this view as well. Revisiting the issue by 18th century philosophers, including Hume, appears to stem from the paradox of the times. The Newtonian scientific revolution, then in full swing, assumed that precise immutable laws determined everything in the world—and that humans can understand these laws and use them to their advantage. Logically, this deterministic reductionist belief contains the seeds of its own destruction: humans are part of the world; hence the precise immutable laws that allegedly determine everything in the world should determine human behavior as well. That would leave no room for free will to change anything, to one's advantage or otherwise. In this imaginary mechanistic world, ethics lack an object of study: the only behavior allowed by the immutable laws cannot be ethical or unethical, good or bad. Ethics require choice, determinism prohibits it. There is an apparent disparity and even "antagonism" between (allegedly deterministic) Nature and (allegedly capable of making good or bad choices) humans, despite humans being part of Nature. Regarding this, Thomas Huxley wrote in “Evolution and Ethics” in 1893: “if the conclusion that the two are antagonistic is logically absurd, I am sorry for logic” [2]. Paraphrasing Hume, it “seems altogether inconceivable” that denial of free will would hold such absolute priority as to demand—and obtain—both denial of logic and debasing moral philosophy. The attempts to relieve this tension, under the general heading of compatibilism, continue to this day. See, for example, this excellent review [3] of attempts to date to resolve the paradox without resorting to repudiation of logic. The discussion in [3] is centered around the concept of “autonomous reflection”: a way to inconspicuously introduce free will, and exceptions to absolute deterministic causality, without explicitly naming either. Another review of the free will vs. determinism debate [4] points out that the high evidentiary bar for free will suggested by its opponents—experimental falsification of the hypothesis that the opposing view is wrong—is equally applicable to causal determinism the opponents favor. It is met in neither case. The details of this argument (continuing for at least 25 centuries) are beyond the scope of this paper, but it appears reasonable to assume that ethics are relevant: choosing ethical actions over unethical ones is both possible and consequential. As summarized by Charles Darwin [5], “[a]t all times throughout the world tribes have supplanted other tribes; and as morality is one important element in their success, the standard of morality and the number of well-endowed men will thus everywhere tend to rise and increase.”

In agreement with Darwin, the authors of [2, 3] link metaethics with evolution. Developing this link, as is shown below, allows using fitness as a criterion to select metaethics models: specifically, the ones yielding useable guidance to their adherents—and, in turn, improving the fitness of those adherents. Fitness in the evolutionary sense is the ability to continue into the future (long enough to produce offspring).

Data from the future (e.g. data on future success of supporters of a particular ethics paradigm) is unavailable at any given time. A time machine, a.k.a. Laplace’s demon, would violate known physics if it existed. For example, no machine can predict the future of the Universe that the machine itself is a part of [6]. An ideal computer is estimated to be approximately 13,000,000 times too slow to predict its own next operation before actually performing it [7]. In addition, Heisenberg’s uncertainty principle prohibits obtaining complete and infinitely accurate information about every particle and wave in the Universe, which the Laplace’s demon requires as the starting point to predict the future. The world is a chaotic system: if the precision of determining its initial state is finite, any deterministic forecast increasingly deviates from reality over time. Furthermore, any finite amount of objective data available at a given time is compatible with an infinite number of deterministic forecasts, depending on assumptions of the model used to derive the forecasts from the data (Figure 1). A further set of assumptions is needed to then select a desirable value, or range, of the variable in question. So, while the absolutist interpretation of Hume’s logic is fallacious, Hume’s concept appears to work in a much narrower sense. Namely, no finite set of descriptive statements provable by objective information available at a given time can suffice to unequivocally determine the truth or falsehood of any prescriptive statement about the future. In other words, deliberate choices necessarily involve an element of subjectivity.

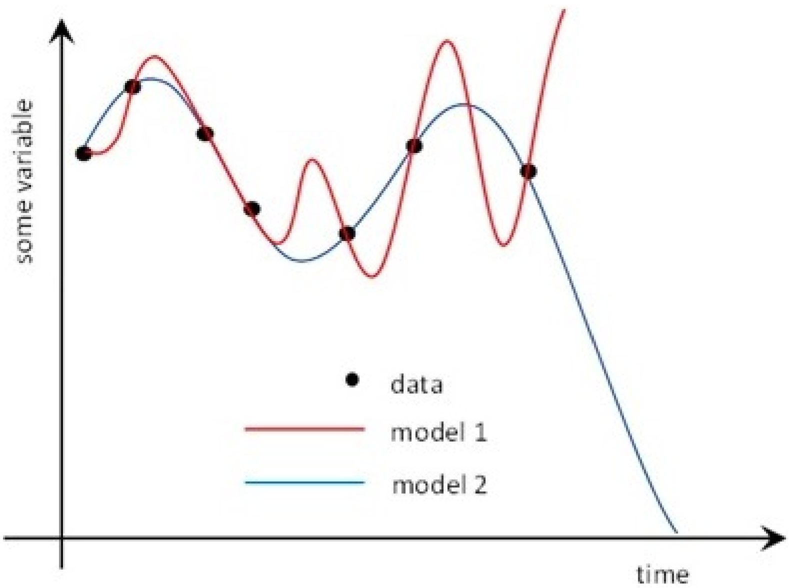

Figure 1. Same data, different assumptions, different models, diverging forecasts.

Unavailability of a time machine yields several non-trivial constraints on viable metaethics models. First, they have to acknowledge the incompleteness and uncertainty of information about the state of the world after the decision is made at the time of making it. Secondly, they have to acknowledge that even the time to make a decision is not uniquely and precisely determined by the objective information available to the decision-maker by that time. Thirdly, they have to acknowledge the uncertainty of any forward-looking ethical evaluation made at a specific point in time; any subjective assumption necessarily involved in such an evaluation may prove wrong in some sense. Yet the practical output of ethics is judging tentative decisions by their expected impact on the future. Therefore, a viable metaethics theory does not deal with immutable absolute moral truths, with the exception of the following explicit assumptions:

(i) continued survival of whoever is asking—that is, of the consciousness advanced enough to concern itself with the question of metaethics—long enough to produce offspring still interested in metaethics is desirable, and

(ii) conditions exist whereby said consciousness can undertake some deliberate action to increase (or decrease) the probability of such survival.

With these two postulates, a metaethics model can be developed into a normative ethics paradigm—and an applied ethics practice. Such development seems timely: current events suggest that humanity could benefit from some moral clarity.

The following sections attempt to apply the principles outlined above to evaluating development scenarios of advanced—civilization-forming—consciousness. It appears that evolutionary ethics logic, applied consistently, makes continuation of this development itself a non-trivial criterion for normative and applied ethics analysis. The more general normative ethics will be considered first, in relation to the role of advanced consciousness in evolutionary cosmology. This is followed by a somewhat more detailed applied ethics analysis of global development scenarios for the next few decades.

2. Normative Ethics Implications of Cosmological Natural Selection

We know only one species, our own, that seeks a meaning to life. The first book on astrobiology, a 1904 monograph by Alfred Russel Wallace—the co-discoverer of natural selection—was titled “Man’s Place in the Universe.” In 1904, scientists still thought Milky Way was the only galaxy in the Universe, still debated the existence of atoms and molecules, and had yet to discover the nature of gene, or atomic nuclei, or photons. The interest in pondering existential questions on such grossly inadequate empirical evidentiary basis sharply contrasts civilization-building humans with all other known species. By 1980, Carl Sagan suggested that we humans are a way for the cosmos to know itself [8].

Sagan’s suggestion that “we are a way for the Universe to know itself” was an extension of the weak anthropic principle: an observable, intelligible Universe has to accommodate intelligent observers. This accommodation is dubbed “fine-tuning” for the incredible precision required: even minute deviations of the values of fundamental physical constants from their present values would have made life, including that of intelligent observers, impossible. The fundamental constants set appears way too precise a fit to be random. How did they get their fine-tuned values?

As a solution to this puzzle, Lee Smolin proposed the Cosmological Natural Selection concept [9]. He posited that an evolving population of Universes—like any other evolving population—is under a selective pressure for the ability to successfully reproduce. The Universes whose fundamental constant sets happen to be most suitable for producing daughter universes, do; and as long as their offspring inherit, with some variation, the fundamental constant sets from parent Universes, the evolution will proceed like it does in biology, with the fittest individuals dominating the population. Smolin argued that black holes are the Universes’ reproductive organs, and the conditions favoring their formation also happen to favor the emergence of life. In the original Cosmological Natural Selection model (CNS, Figure 2), life, intelligence and civilizations are relatively accidental byproducts of the evolution of Universes.

Smolin’s concept was extended by Louis Crane, Edward Harrison and others (see [10] for review). They hypothesized that, rather than accidentally emerging in a selective process driven by the requirement to efficiently make black holes, life—and, specifically, intelligent, civilization-forming life—may be the very factor a Universe needs to efficiently reproduce (hence these models are collectively called CNS-I, for Intelligence-mediated Cosmological Natural Selection). For example, (as Robert Zubrin points out, [11]) black holes may well be the technology powering (and propelling) advanced technological civilizations. This could give evolutionary advantage to the home Universes of such civilizations, as they deliberately increase the flux of the matter/energy towards black hole formation—hence increasing their home Universes’ reproduction rate. In a reversal of the original CNS view, here the Universe creation could be an accidental byproduct of technological civilizations’ metabolism. The ability to evolve life, and eventually technological civilizations, is therefore “in the interest” of a Universe if its “purpose” were for its offspring to dominate the universe population—as James Gardner proposed in his “Selfish Biocosm” hypothesis [12].

However, black holes constructed by a technological civilization for its utilitarian purposes would perhaps be optimized for those purposes, rather than for producing daughter universes in the (likely somewhat imperfect) image of its home Universe. Consequently, the offspring may have little, if anything, in common with the parent—likely inheriting none of the parent's "fitness" for "reproduction" and voiding the parent's evolutionary advantage. Hence "selfishness" of a civilization would be selected against: to retain its home Universe's advantageous fundamental constant set in the daughter universes it makes, a civilization likely has to make a deliberate effort to do so. There doesn't appear to be any way for that civilization to directly benefit from the results of such effort; its motivation for spending resources on pursuing this goal would therefore be largely altruistic. It can, therefore, be argued that the ability to evolve not just any life, but intelligent and ambitious life developing an altruistic technological civilization is a cosmological natural selection criterion. Ethics is an evolutionary metric.

CNS-I framework allows assigning a tentative meaning to life, and particularly intelligent life. According to Clement Vidal, the evolutionary meaning of life is pursuit of immortality [13]. The immortality scale of interest to H. Sapiens has evolved from individual to family, tribe, nation, species, ecosystem, biosphere. Viewing evolution of life, including development of advanced intelligence, as a process integral to overall cosmic evolution allows assigning a "purpose" to advanced civilizations and a moral justification to progress towards emergence of such civilizations [7, 14, 15]. The "purpose" would be to let their home Universe know itself well enough to deliberately reproduce. In this model neither Universes nor civilizations are accidental: both are a part of an evolutionary cycle of life (Figure 3). There appears to be a selective pressure for universes evolving altruistic technologically advanced civilizations with panbiotic ethics. One of these may have created our Universe.

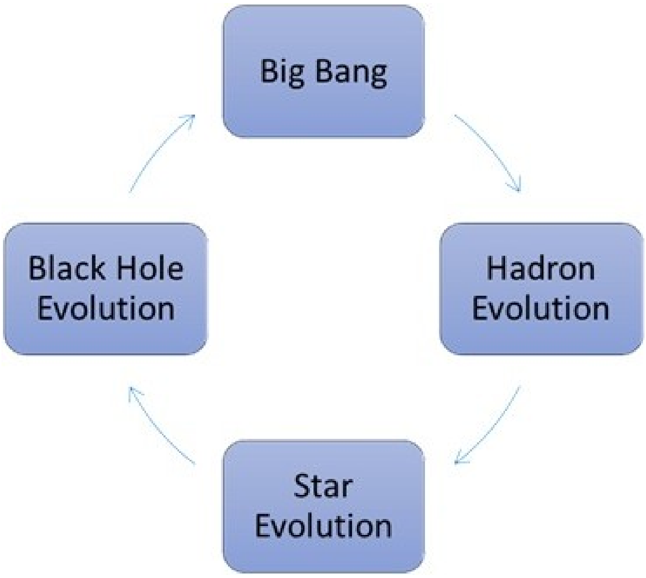

Figure 2. Cosmological Natural Selection.

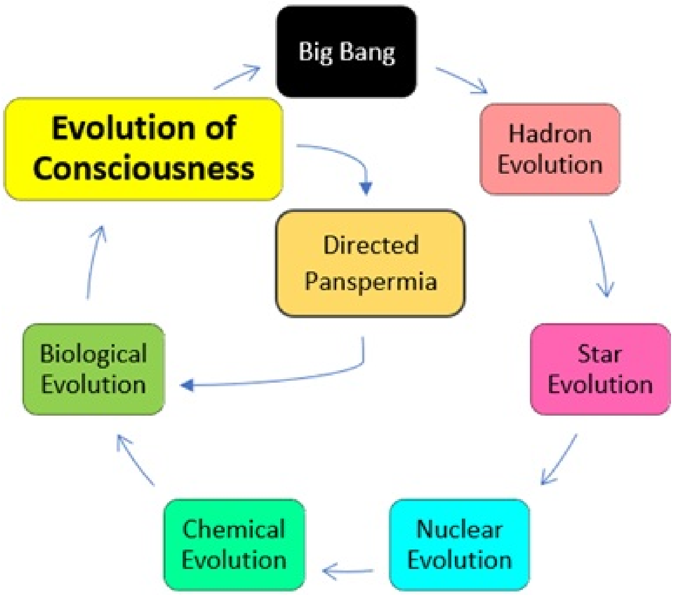

Figure 3. Intelligence-Mediated Cosmological Natural Selection.

3. Evolutionary Normative Ethics of Directed Panspermia

The ultimate origin of life is probably abiological. Yet it appears increasingly likely that life on Earth emerged way too fast to have evolved both abiologically and locally [16]. The Last Universal Common Ancestor, LUCA, complete with the sophisticated machinery of genetic coding, translation, transcription, replication, and catalytic metabolism with thousands of networked reactions, is estimated to have evolved almost immediately (on the evolutionary timescale) after the planet's surface cooled down enough for rocks to solidify. There doesn't appear to be a way for all these processes to evolve this fast from scratch (in contrast to the billions of years it took evolution to then come up with the comparatively "minor" add-ons: photosynthesis, cell nuclei, mitochondria, sexual reproduction, multicellular life forms etc.).

Once started, life spreads over its home planet—and eventually beyond, in a process called panspermia. An Earth-like planet with a biosphere likely broadcasts life-carrying meteoroid particles for as long as the biosphere is active enough—perhaps about 2.5 Gyr [17]. Such emitter planet is estimated to have an exobiosphere of approximately 5 pc, or 1.5×10^{14} km, radius, containing about 10^{21} viable microorganisms [18]. The total number of descendants—biospheres of exoplanets successfully seeded by fortuitous panspermia over the emitter biosphere's lifetime—can be estimated to range between several and several dozen (Shenderov, manuscript in preparation). Unmediated diffusion of life across interstellar distances is slow.

Just like a universe can get an evolutionary advantage from a civilization deliberately assisting its reproduction, so can a biosphere. A civilization evolving the ability to mediate its home Universe's reproduction would likely engage in certain types of preparatory behavior increasing its chances of success. One of these may be developing black hole technology (or some alternative technology enabling deliberate creation of Universes). Another is helping life spread through its home Universe—so intelligent life's abundance and diversity increase, and so do the Universe's chances to have viable offspring.

Promoting the spread of life means both directed panspermia and space settlement. Space settlement with designer biospheres, modelled on the civilization's home biosphere, allows rapid spread of advanced life forms—bypassing billions of years of evolution otherwise required for such life forms to evolve. Despite the common origin, the daughter civilizations will coevolve with local environments—and so necessarily diversify. Exchange of information may continue among such civilizations—which can, therefore, be regarded as belonging to a common extended noosphere.

Directed panspermia, on the other hand, involves seeding alien planets with primitive life forms—which then will only establish mature biospheres, including advanced civilizations, billions of years later (if ever). In terms of covering both physical spacetime and diversity phase space, it is complementary to the space settlement efforts.

Directed panspermia is deliberate transport of (micro)organisms across space as seeds of life on other planets. A sufficiently advanced technological civilization can, if it chooses to, accelerate the spread of life by many orders of magnitude compared to fortuitous panspermia. Increasing the flux and individual mass of life-carrying meteoroids, their viable payload, and their transit velocity requires only known technologies and a deliberate investment of resources, primarily energy. A Kardashev Type I civilization of Earth would command 5×10^{24} J of energy annually. Budgeting just 1% of that to perform directed panspermia would make it possible, at only 1% energy efficiency, to send enough panspermia packages in several centuries to seed all of Milky Way Galaxy's estimated 10^{11} habitable-zone planets (Shenderov, manuscript in preparation). Every human alive today would then be succeeded (billions of years later) by about a dozen biospheres directly descended from our home one. After the Milky Way, humanity (by then exceeding Kardashev Type I power level) can eventually seed the other 10^{11} galaxies in the observable Universe. The overall target space for terrestrial-type life seeding may increase from less than a hundred to about 10^{22} by evolving a technological civilization with assertive panbiotic ethics. If this civilization chooses to spread life through the Universe it can fail, but if it doesn't it can't succeed.

Thus, it is at least possible that the origin of life on Earth was LUCA being brought to Earth by an extraterrestrial civilization's directed panspermia campaign. Altruistic panbiotic ethics driving such a campaign may be the foundation of terrestrial biosphere, and therefore part of human heritage.

Of the multiple panspermia probes that may have seeded the Earth, the ones that developed into our biosphere were of the same origin. The only known genetic code is but one option in an unimaginably vast chemical space [19], hence panspermia from different primary (independently abiologically evolved) sources is astronomically unlikely to have compatible genetics and biochemistry. The fact that all known terrestrial organisms share the same genetic code suggests that a biosphere, once established, is extremely resilient against subsequent panspermia attempts. And the simultaneous arrival at the same destination of panspermia parcels from multiple origins is astronomically unlikely. Therefore, concerns about theoretical alien biospheres succumbing to a few terrestrial microbes, weakened by the rigors of interstellar travel, contradict evidence-based science [18–20].

Directed panspermia activity would be mostly altruistic: the civilizations engaging in it cannot benefit from it in any pragmatic, myopically-rational way—unless you consider giving humans a sense of common goal, and the resultant changes of worldview, attitudes and behavior a pragmatic benefit.

Charles Darwin already recognized the apparent contradiction between the desire for individual success and altruism [5]. In strictly rational terms, an individual taking risks and making efforts on behalf of the group is at a disadvantage compared to the "free-riders" who don't. But altruistic behavior evolved early in evolution of life on Earth: procaryotic cells form colonies and differentiate to perform specialized functions, where individual cells accept metabolic burdens and survival risks to benefit the colony (for review, see [21]). Single-celled amoeba Dictyostelium discoideum, when stressed, forms multicellular fruiting bodies, with about 20% of the cells forming a structural support (stalk) allowing the other cells to form spores [22]. But extensive, sustained and evolving cooperation beyond biological "kin" appears to be uniquely human among known life forms [23]. Evolving—expanding—definition of "self" is what appears to reconcile selfish and altruistic motives as a civilization advances.

Evolution of altruism and cooperation are examples of violation of short-sighted individual rationality implied (or explicit) in many modelling studies of human and animal behavior (hence the "puzzle of human cooperation", [24]). The costs of altruistic behavior are immediate and evident; the benefits, less so—unless culture preconditions individuals to take common good into consideration. For example, in many human cultures, being a defender of the tribe increases the individual's attractiveness as a reproductive partner—despite the obviously increased risks of being unavailable for childcare in case of dying in battle. At the individual level, this behavior is highly irrational. Yet over time, cultures that promote (a calibrated level of) irrational, altruistic behavior accumulate evolutionary advantages over those that don't.

The ability to irrationally set long-term goals, and then sustain the rational pursuit of those goals, appears to be the key emergent property of advanced cognition that enables civilization-building. Nabta Playa observatory, for example, required astronomical data accumulated over multiple generations—long before the invention of writing. Civilization is a combination of sustained deliberate activities; the most innovative of these activities tend to be the least rational, as neither all of their consequences nor the consequences' "optimality" can be fully established by the time it's decided to carve a Sphinx or fly to the Moon. This feature (that John Stewart termed "commitment before certainty" [25]) appears to be a prerequisite to the development of a civilization by trial and error, where spectacular breakthroughs are rare and unpredictable: requiring certainty before action paralyzes action.

No civilization can rationally justify the resource expenditure on directed panspermia (or Universe replication) any more than humans could rationally justify building the Nabta Playa observatory or carving Sphinx or painting animals in the impenetrable darkness 1 km from the entrance to the Rouffignac cave. While a lot of rational thought must have gone into achieving each of these goals, setting them in the first place appears somewhat irrational. Apparently, irrationality is what allows us humans, lacking access to a time machine, choose what to be rational about. Hence "commitment before certainty" is a normative ethical obligation to act without complete knowledge: if you try you can fail, but if you don't you can't succeed.

There is, for example, nothing objectively "better" about the blue-green watery Earth than the brownish-red dusty Mars or gray dusty Ceres. Humans just happen to subjectively, irrationally prefer the Earth with its life—including ourselves. In the evolutionary ethics framework, this irrational preference places humans under ethical obligation to preserve and propagate life as they know it from the biosphere that evolved them. Alien civilizations that evolved under extraterrestrial conditions are under similar ethical obligation to preserve and propagate life as they know it from their origins. Expanding, beyond Earth, the one biosphere we know exists is associated with unknown risks to hypothetical aliens. However, without our deliberate help terrestrial life would be at risk of extinction from cosmic catastrophes we could protect it from (and plant its backup copies elsewhere in case the protection fails). Terrestrial biosphere would also be at a tremendous competitive disadvantage to any alien biosphere whose civilization is guided by assertive panbiotic ethics. These are risks to the life that we know exists.

A biosphere, like any complex system, evolves in a path-dependent fashion [26]. As a part of Earth's biosphere, human civilization and its culture reflect an outcome of a long sequence of events unique to our planet of origin. Human "identity" embodies at least 3.8 billion years of one-of-a-kind process of evolving complexity (to the point of concerning itself with ethics). In terms of evolutionary ethics, deliberately facilitating the continuity of this process is a moral obligation of our species to the biosphere it evolved in. Denying the terrestrial biosphere the evolutionary advantage it earned by evolving us is, within this framework, grossly unethical.

Other frameworks lead to different conclusions. For example, a moratorium on deliberate panspermia [27] has been proposed "until we can predict... long-term outcomes"—read forever, as making such a prediction covering an arbitrarily long time requires a time machine. In absence of a time machine, the proposed moratorium amounts to assuming that any alien life, or no life at all, is *a priori* preferable to terrestrial life and its extraterrestrial progeny. The paper [27] quotes "estimates that a billion years of existing sentient life on Earth might be equivalent to 18.2 trillion years of suffering (without considering the possible compensatory effects of positive welfare states)". Indeed, once "positive welfare states" are ignored, the remaining welfare is negative—and can then be used by welfarists to justify assigning life a negative value. The paper further posits that "The argument for panbiotic ethics is grounded in a principle of equivalence between descriptive and normative statements concerning living systems [11, 28]. However, according to classical interpretations of logic, attempting to derive the latter class of statements from the former is invalid, otherwise known as "Hume's Guillotine" [29]". In fact, panbiotic ethics do not require such equivalence, just the assumptions that (i) life's value is net positive, and (ii) it can be deliberately increased, as discussed in Section 1. Furthermore, the "Hume's Gilliotine", if understood in this all-encompassing sense, is itself invalid (see Section 1). Perhaps the proposed moratorium itself should be suspended until we can predict its long-term outcomes.

4. From Normative to Applied Ethics: Evolution of Intent

The only biospheres that can get a deliberate reproductive boost are the ones that evolve civilizations able and willing to provide it. Ethics affects both a civilization's ability to aid life in pursuit of immortality and its willingness to do so—and so becomes a very pragmatic, existentially relevant field of thought.

First, in order to protect its home biosphere from cosmic catastrophes, plant its backup copies elsewhere in case the protection fails, and seed its home Universe with panspermia parcels, a civilization has to last long enough to learn how to do all of these things. And ethics appear relevant both to a civilization's emergence and to its life expectancy. Anthropologist Margaret Mead allegedly regarded a 15,000-year-old broken, and healed, femur as the earliest sign of human civilization (mainstream misanthropes, naturally, declared this uplifting story "misinformation" [30]). It turns out that a broad variety of non-human species benefit from intra- and interspecies cooperative behaviors (see [31] for review). Mammals, birds and even ants take care of their wounded comrades. Most species take care of their young—often engaging in collective behaviors, like group migration or colonies, occasionally involving more than one species. Whales, buffaloes and birds help other species avoid predators, often risking their life and limb in the process. Even individual procaryotic cells under environmental stress accept metabolic burdens and survival risks to improve the overall survival chances of a colony they form in these conditions. How come none of these have civilizations, but humans do?

Our cooperation evolves [28], and it evolves through stories—informative and imaginative—rather than genes. So, the pace of human evolution—and that of the biosphere that evolved humans—is no longer limited by biological mutation and generations-long selective process. With evolving collective consciousness, i.e. culture, humans out-evolve other terrestrial life forms. The only global civilization known so far—the human one—developed (hesitantly) as a progression of increasingly bigger groups of increasingly more diverse people pursuing increasingly more ambitious goals. When a task is difficult enough, specialization and cooperation tend to win over trying to do it all yourself as best as you can. Human history is the story of survival of the more cooperative, from a small tribe in a cave to global empires exploring Space and wrapping our home planet in the World Wide Web of knowledge and communication. Charles Darwin expressed this trend like this: "[s]elfish and contentious people will not cohere, and without coherence nothing can be effected. A tribe rich in the above qualities would spread and be victorious over other tribes: but in the course of time it would, judging from all past history, be in its turn overcome by some other tribe still more highly endowed. Thus the social and moral qualities would tend slowly to advance and be diffused throughout the world" [5].

The causal relationship Darwin asserted may be difficult to ascertain in specific circumstances. Success or failure of groups of humans apparently depends on many factors besides their morality, with effects of the latter often masked by the former. For example, human cooperation and equitable access to water likely enabled the ancient irrigation empires of Nile, Tigris, Euphrates, Indus, and Yellow River valleys. These civilizations are among the most studied chapters of human history; nevertheless, the contribution of ethics to their development remains speculative. Circumstances are very rarely as clear and well-documented as they were for the so-called Nuer conquest [29]. In 19th century, Dinka people in South Sudan rapidly lost territory to their Nuer pastoralist neighbors with better cooperation skills. Nuer land holdings quadrupled over a period of just 70 years. This episode is particularly telling because the Nuer had recently been a subgroup of the Dinka, with the two peoples sharing language, technology and environmental conditions.

Most of human history resists the detailed analysis made possible by these exceptional circumstances. The causal connections between public sentiment expressed by Leonardo DaVinci's "we must stretch ourselves to the very limits of human possibility" and the spectacular artistic, scientific and social achievements of the Renaissance; or between public sentiment expressed by Francis Bacon's assertive "Knowledge is power" and the ensuing Industrial Revolution; or between public sentiment expressed by Dr. Martin Luther King's "I have a dream" speech and the success of cooperative efforts by about 400,000 Americans to land humans on the Moon, are tenuous at best. Yet Darwin's notion that morality and culture correlate with the evolutionary success of the society sharing that culture appears to hold—not as a strict, inviolable law, but on average and over time. And at least in some cases where the sequence of events can be unequivocally established—such as collecting and collating astronomical data before constructing the Nabta Playa observatory, or learning to tip spears with stones before hunting with stone-tipped spears—the intent to act preceded a sustained effort long before its outcome was clear. This suggests occasional "commitment before certainty" as a necessary ingredient of evolution of culture: various groups commit resources to deliberate actions according to their different belief systems, and the cultures whose beliefs prove beneficial get a better chance to become ubiquitous. While often hard to confirm in specific instances, this assertion appears logically inevitable from reductio ad absurdum analysis. Its opposite statement is that certainty should always precede commitment. If this statement were true, it should never be made: making it amounts to a commitment (to never taking action until its outcome is certain) before certainty (that it's always a good idea).

A "commitment before certainty" has to be sustained for some time to produce a desirable effect, or corrected if it produces an undesirable one. The first feature is persistence. The second is corrigibility. Both are components of culture, and so is ethics that yields the criteria to evaluate the outcome as desirable or undesirable.

Persistence and corrigibility both evolve. Phenomena whose features can be construed as persistence and corrigibility emerged long before civilizations, intelligence, or even life. Air molecules at room temperature and atmospheric pressure persist in straight-line motion at constant speed between consecutive collisions with other air molecules. The persistence time is hundreds of nanoseconds. In a gradient of temperature and/or pressure, this motion—termed persistent random walk—is biased: an air molecule is more likely to get hit on one side than the other, so it preferentially moves along the gradient. Escherichia coli, a procaryotic cell, moves in liquid through a sequence of approximately linear "runs" interrupted by periods of reorientation, or "tumbles". The persistence time for *E. coli* is about 1 s. In a gradient of a chemoattractant, the cells preferentially move toward the source by swimming for a longer time, on average, towards the source of the chemoattractant than away from it [32] in a process called chemotaxis. They correct their swimming direction using a signal from chemoattractant receptors. The chemotaxis system is largely preserved since LUCA, for 3.5 billion years [33]. Meantime, the estimated 2×10^{30} bacteria on Earth accumulate approximately 10^{-3} mutations per cell division [34] approximately every 15 hours in the wild [35]. The total number of variants tested over the 3.5 billion years is, therefore, approximately 4×10^{36}, yet none of these has resulted in a radical modification of the existing chemotaxis system in procaryotes.

More advanced life forms demonstrate even more sophisticated examples of apparently "intentional" behavior: for example, insects, birds, caribou and whales endure months-long seasonal migrations twice a year. This behavior appears to be genetically inherited, with little variation, from generation to generation of these organisms [36].

Humans, on the other hand, had the ability to develop artifacts like Nabta Playa observatory over the course of 800–900 years. These artifacts embodied centuries' worth of accumulated astronomical and technological knowledge, collated long before the invention of writing. The knowledge is believed to have progressed from the ability to recognize celestial bodies—Orion belt, Sirius, Arcturus, α Centauri—to quarrying, shaping, dressing and placing megaliths weighing several tons to mark an increasing number of recognized celestial alignments [37]. Invention, and rapid development, of writing is a further example of coevolution of human cognition and human action; "we have become able to leverage material forms for cognitive purposes: we recruit and incorporate them into our cognitive system..., exploit them to accumulate and distribute cognitive effort between individuals and generations..., and use them to recreate phenotypic change in new individuals and generations" [38]. This sharing of cognitive tasks depends on the availability of those able and willing to participate: for example, a single bonobo found to have a unique ability to process abstract concepts [39] has no other bonobos to share cognitive tasks with, precluding the development of a bonobo civilization. Chimpanzees of one troop were observed to make hunting tools in a multistep process; however, they were unsuccessful in hunting with the tools in 21 out of 22 observed attempts, and the tools were discarded [40]. The putative learning of toolmaking skills by chimpanzees, and navigational skills by homing pigeons [41], through imitation is often interpreted as evidence of proto-culture. This anthropomorphizing interpretation is not entirely convincing, since in every known instance it was representatives of human culture doing the research on the nonhuman subjects, not the other way around.

Early hominids, distant ancestors of modern humans, maintained and perfected the Oldowan stone toolmaking technology [42], and its derivative Acheulian and Levallois knapping technologies [43], for 2.6 million years. Even the scarce available record shows examples of independent development by trial and error, with some of the sites showing primitive techniques as much more advanced technology was in use elsewhere at the same time [43]. The technology of hafted stone-tipped spears emerged about 500,000 years ago [44], also before the appearance of anatomically modern humans. Importantly, while observant hominids may have noticed accidentally chipped flint stones, shaping stone tools requires dozens, if not hundreds, of individual operations, suggesting imagining a desirable result and checking the unfinished product against that image. Sticks with attached sharp stones are not known to form by accident, so the stone-tipped spears have no conceivable accidental prototype. Learning to construct a stone-tipped spears good enough to be of practical use involves a long arduous trial-and-error process. There does not appear to be a rational (based only on *a priori* available information) way of predicting that such effort will pay off. This is perhaps the first unequivocal example of a sufficiently complex human-made system (or process) that required irrational thinking: imagining things that did not exist at the time.

Cross-generational sharing of cognitive tasks enables tackling problems humans cannot solve in a single lifetime, like accumulation of astronomical data and technology for the Nabta Playa observatory or the Antikythera mechanical calculator. This involves faith: trusting statements by others (regarding both the irrational choice of problems to tackle and the rational accumulated experience to date) one is in no position to exhaustively verify. This trust-based expansion of collective memory and processing bandwidth beyond any individual's abilities is an apparent prerequisite to Isaac Newton's "if I have seen further, it is by standing on the shoulders of giants". This sharing of cognitive tasks is central to cumulative cultural evolution [45, 46] progressing through symbolic spoken language, mythology, written language, scientific method, printing, industrial revolution, telegraph, radio, spaceflight, Internet to collect and disseminate information, abstractions and ideas for evaluation, retaining or rejecting. The earliest known cave painting at Leang Karampuang (51,200 years old) depicts, among other things, mythical semihuman creatures (therianthropes), products of human imagination [47]. At approximately the same time and in the same general area, the first unambiguously confirmed successful ocean crossing resulted in settling Sahul (modern Australia) [48]. This clearly required deliberate action: the chances of successfully establishing a robust founding population [49] at random, i.e. without intent, are exceedingly low [48]. The possibility of successful accidental settlement was demonstrated only by assuming that groups of at least 40 people are regularly (every 20 years) "washed off" from only a few kilometers' stretch of shoreline along the settlement route, to land on an island at least 100 km away (several shorter crossings of 20–30 km were assumed to be achieved by the same mechanism). No such event was ever recorded in human history anywhere along the 2,500,752.85 km of shoreline worldwide [50], despite human population (particularly along seashores) currently being hundreds of times higher than it was 50,000 years ago.

Human settlement of physical space and that of mental space proceeded in parallel, suggesting a commonality. This commonality appears to be their coevolution with (somewhat irrational) human intent and (mostly rational) human knowledge and skill—in other words, the cumulative cultural evolution of humans. The ability to irrationally set progressively more ambitious, longer-term goals shared among progressively bigger groups of humans, and then sustain the rational pursuit of those goals long enough for some of those goals to be achieved, appears to be the key emergent property enabling the self-organization of life through trial and error into a civilization.

Evolving ethical intent appears to be critical to the role of civilizations in the evolution of their home biospheres. In order to protect its home biosphere from cosmic catastrophes, plant its backup copies elsewhere in case the protection fails, and seed its home Universe with panspermia parcels, the civilization has to choose to do so. It has to accept the responsibility for its home biosphere's long-term survival. Evolution of intent to aid terrestrial life in settling space starts with caring for our planet of origin (Figure 4). Humanity's track record here is rather promising (even though, like all human endeavors, it involves trial and error). Early in the civilization's history, humans learned to take care of symbiotic species—dogs, wheat, barley, goats, pigs, cattle—and deliberately increase biological productivity of river valleys (Nile, Tigris, Euphrates, Indus, Yellow rivers). Later, artificial oasis technology emerged and allowed settlement of arid areas (and development of transcontinental trade routes through deserts). Native Americans, among others, perfected techniques for supporting abundant wild populations of bison, elk, and caribou, with obvious benefits to the whole ecosystem. As human civilization developed, it moved farther and farther beyond myopic utilitarianism of immediate survival, creating first stone age sacred sites, then Hanging Gardens of Babylon, medieval game reserves and royal forests, then modern National Parks. Currently, these and other protected areas cover 17.6% of the Earth's landmass, and movement is underway to increase this proportion to 30%. Humans built Svalbard Seed Vault that safeguards planetary genetic heritage (another one is planned to be built on the Moon); established a Planetary Defense Coordination Office to track near-Earth objects that may threaten our planet; and conducted a successful planetary defense test mission to deflect an asteroid. Humans created Nature preserves and Endangered Species legislation—protections unavailable to the over 99.9% of the species that ever existed on this planet that went extinct before humans arrived.

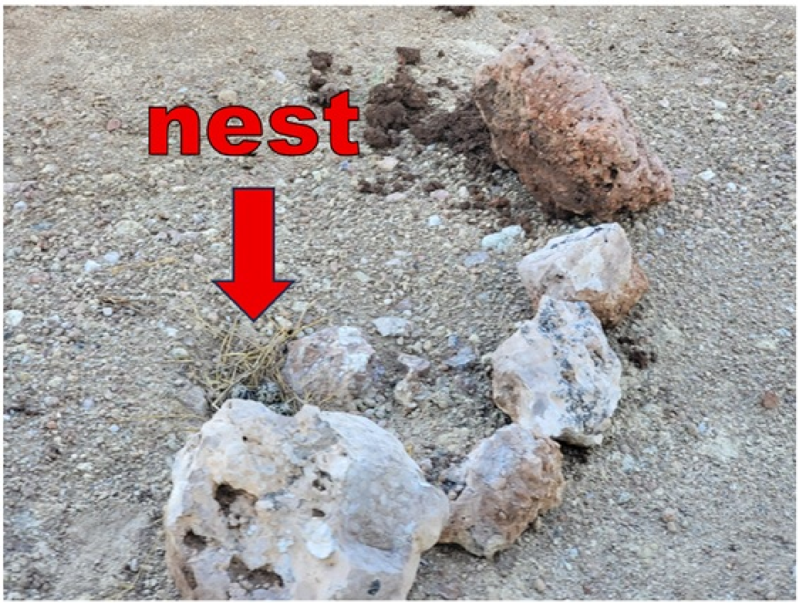

Figure 4. Black-winged Stilt (*Himantopus himantopus*) nest on a dirt road in Kenya, carefully marked by humans (*Homo sapiens*) to prevent accidental damage. Photo by the author.

Continuation of this trend depends on prevalent human ethics, which defines how humanity manages its resources—the most important resource being human creativity and ambition. And the dynamics here are alarming—at least in the developed countries of the global North, which are traditionally considered to be the vanguard of progress.

5. Evolutionary Applied Ethics of the Nascent Global Civilization of Earth

The global North, where about 13% of humanity lives in relative comfort on 30% of humanity's energy budget, for centuries dominated the civilization—in economy and finance, technology and science, politics and war, literature and media. It accounts for 44% of all human economic activity, measured as PPP GDP. Even decisions on what countries to include in the global South are made in the global North.

The North's dominance used to be reassuringly (and somewhat convincingly) attributed, at least in part, to its superior ethics: the ability to tell good from bad [51]. Indeed, the ideas of Renaissance, French Revolution, Industrial Revolution, American Revolution were progressive for their time. Capitalism generally rewarded innovation and ambition, supporting the uplifting ideals of meritocracy and egalitarianism. Routine misogyny, xenophobia, social stratification, colonial atrocities, racism and slavery did little to shake the Northern powers' confidence in their moral superiority, it being allegedly the white man's burden to carry the light of civilization to the allegedly lesser humans. Convenient theoretical foundations were built to explain away the disconnect between the high-minded ideals and contemptible practice, from "scientific" racism to Malthusianism and social Darwinism. As long as the living standards were going up—which they were, quite unevenly but practically everywhere and for practically everyone—the general attitude in the global North was that of optimism and pride.

The global North is no longer the optimistic, upbeat place it once was. "The optimist may be secretly envied, but he is publicly despised. His pronouncements are regarded as expressions of simple-minded blindness or as cynical propaganda. Optimism is not regarded as intellectually respectable. It was not always so: there have been times when optimism was not merely considered worthy of rational argument, but was widely accepted by thinking men" [52]. Only 6% of Americans believe the world is getting better—vs. 41% of Chinese [53]. And, using the Kardashev metric—energy a civilization controls—it's understandable. A 2.8% annual growth rate in energy usage, corresponding to the 25-year doubling period (the Industrial Revolution pace of progress) is more often than not exceeded in the living memory of modern Chinese—and, more often than not, not reached in the living memory of modern Americans. 15 million km of transmission lines were added worldwide between 2013 and 2023 [54], for 1.5 million km annual average. Of this total, 12.5 million km was in the emerging markets and developing economies, primarily China and India. Meantime, in 2023 the US built only 88.5 km of high-voltage transmission lines—and 405 km of power lines of all kinds [55]. People perceive progress as time derivative of quality of life, and energy use is a rather reliable stand-in for quality of life. So, Americans feel that the world is stagnating—and quite a few Chinese feel it's moving forward.

Perceptions matter: the prevalent attitudes in a society drive its resource allocation decisions. A culture chooses an optimistic or pessimistic belief set, through which it filters available information and evaluates feedback signals. The resultant level of willingness to commit before certainty, in turn, sets the upper limit of its aspirations. You can fail if you try; but if you don't choose to try, you can't succeed. This feedback loop acts through subjective worldviews to produce objective, tangible outcomes [7, 56]. The perception in the affluent North of its own moral decline may be an illusion [57], but the prevalence of such cynical attitudes is nonetheless an objective and well documented fact [58]. Naturally, the cynicism and suspicion aimed by Northerners at non-Northerners are even more pronounced [59, 60]. The recent NATO commitment to increase military spending mandate from 2% of GDP in 2025 to 5% in 2035 [61] is an example of resource allocation trends corresponding to (and arguably driven by) these trends in worldview.

Culture-dependent resource allocation under uncertainty determines responses to perceived crises. The most pressing of these at the moment is, arguably, replacing fossil fuels with renewable energy sources [62]. At present, 82% of humanity's energy budget comes from fossil fuels. They are used millions of times faster than they form in the Earth's crust. The low-hanging fruit is long gone, and what's left gets harder and harder to extract. About 40 years from now, extracting a barrel of remaining oil will cost as much energy as it contains, with nothing left to support human activities. Continuation of human civilization therefore involves switching its energy metabolism from fossil fuels to renewable sources [62]. Fortunately, our local star, the Sun, irradiates our home planet with nearly 10,000 times as much energy as humanity is currently using—and will continue to do so for the next billion years or so. The Sun illuminates half the Earth at any given time, hence one obvious possibility for harnessing its power is to wrap the planet in a global electric power grid—so humans on the day side send excess power to those on the night side, and 12 hours later the flux reverses. If done in this cooperative way, the transition is expected to cost $127 trillion [62], close to the $117.1 trillion 2025 global GDP and dwarfing the Apollo program ($.31 Trillion, inflation-adjusted) and World War II ($4 Trillion, inflation-adjusted). The alternative, based on local energy storage instead of cross-border trade, is estimated to cost $701 trillion (without accounting for either the experience curve discount or demand growth [62]). At 5% of the global GDP, the global power grid-based system can be built in 20 years—in time to switch from fossils to renewables while the power needed for the transition is still available. This would be an unprecedented effort requiring, among other things, reliable public support over an extended period—which depends on the prevalent ethics of the respective societies. Refusal to adopt the ethics of global cooperation and tolerance, and hence join the global grid effort, would incur a self-inflicted 450% cost penalty, setting back the national economies of the countries that choose the Malthusian zero-sum us-vs-them ethics. That, in turn, would increase the incentives to exercise all available options, including military, to ensure preferential access to the remaining fossil fuels (and, for a good measure, to other tangible resources as well). This adversarial scenario risks escalating into a global (thermo)nuclear resource war, possibly exterminating not only the human civilization but most if not all of the terrestrial biosphere.

So, the likelihood of our civilization's survival beyond the short fossil-fueled burst demonstrably depends on human ethics. Contrary to the analysis [27] (which infers that "time is very cheap in this equation" from assuming a non-positive value of life until proven otherwise), the assumption that life's value is net positive leads to the opposite conclusion. Time is critically valuable—once you posit a positive value for the path-dependent cumulative human culture that evolved from the terrestrial biosphere and might be lost unless humans undertake deliberate and timely efforts to extend it beyond the brief fossil-fueled era [62]. In that view, continuation of human civilization and its eventual engagement in forming terrestrial exobiosphere are parts of the same cumulative evolutionary process.

Human resource allocation works through the financial toolkit. The World Bank and the International Monetary Fund—conceived in 1944 as cornerstones of the global financial system—embody the economic dominance of the global North. By statute, they are led by citizens of the US and EU, who are products—and are among the creators—of the Northern culture's crisis described above. Which makes the flow of civilization's resources depend on the ethics of the North. Which are, in practice, increasingly isolationist and protectionist, in full accordance with the currently prevailing Malthusian zero-sum-game worldview [63]. In a zero-sum world, someone's advantage means someone else's disadvantage. In this worldview, it makes no sense to fund somebody else's ability to utilize the allegedly limited resources you want for yourself. An increasing fraction of the population in the affluent North feels aggrieved, a narrative reinforced by populist politicians [64] and escalating through social positive feedback loops to unmasked xenophobia [65].

Global South, a.k.a. the developing world, has the distinct advantage of developing—which the North interprets as a threat and acts accordingly. For example, GEIDCO—a Chinese company set up to promote the global power grid—failed to find partners in the global North. The International Solar Alliance, headquartered in India, promotes development of solar—including, again, the global power grid. Among the 170 international partners they managed to sign up, many are based in the global North—including the World Bank, which in 2016 committed to mobilizing $1 Trillion for the initiative before 2030. To date, after 2/3 of the time has passed, verifiable transactions amount to no more than $4B, or 0.4% of the promised amount. Understandably disillusioned with institutions set up by the North 80 years ago to control the flow of global resources, the developing countries find alternatives.

China grew its high-speed railroad network from 118 km in 2008 to 37,900 km in 2020, developed a Great Green Wall to push back desert and grow forests, built a space station, a global navigation system, and a modern power grid—including the world's longest UHVDC power line—all without waiting for anyone's permission. India built the biggest irrigation system in the world, the Indira Gandhi Canal system, fully relying on local resources and financing. The system is now being upgraded with funding from BRICS's New Development Bank. Ethiopia, after 47 years of effort, managed to mobilize local resources and financing needed to build the Grand Ethiopian Renaissance Dam—completed in 2025. Comparable levels of persistence and teamwork are rare in the global North after the Apollo program. Global South, forced to rely on itself, haltingly learns to do just that. And the rugged individualism and fierce self-reliance romanticized in the popular culture of the North are increasingly seen as a handicap (they have a traceable impact on the decline of American railroads and power grid [66]), while the African collaborative ethics of ubuntu [67], and Confucian ethics of Xin (trust) [68] are gaining global recognition.

The developing world increasingly needs improved access to water [69]. Approximately 31% of South America, 66% of China, 69% of India and two-thirds of Africa is drylands. Tehran, Kabul, Mexico City and Cape Town are under severe water restrictions. Fresh water availability is the critical rate-limiting factor in the global South's development—and in overall biosphere productivity in these parts of the world. Improved water availability could both positively impact the quality of life of humans who live there (and, indirectly, that of other humans as well) and create an enormous carbon sink by removing the water availability constraint on net primary production (of biomass by photosynthesis). Currently, less than 0.5% of the water on the planet is available to the land-based life. But fresh water availability can't be a constraint to an Earth biosphere whose civilization can afford the energy for desalinating and pumping water where necessary. These are both very mature, if energy-intensive, technologies. Across the global South, people learn—through trial and error—to transform inhospitable drylands into oases where human and nonhuman life can thrive.

This newfound confidence of the global South extends beyond immediate utilitarian needs, despite the obvious abundance of those. Thorium reactor technology is being developed in India and China; these countries and Russia have active nuclear breeder programs [62]. It has been recently assessed that China leads the world in 90% of critical technologies [70]. In 2023, India became the first country to land a robot near the Moon's South pole. In 2019, terrestrial plants for the first time sprouted on another celestial body—aboard a Chinese-made spacecraft parked on the Moon. The expertise accumulated building MAGLEV trains boosts the Chinese ambitions to build a MAGLEV-based space access system by 2028.

This last development may be the first step in moving large-scale energy harvesting, and use, off the Earth surface. Developing Kardashev Type I civilization requires transferring most of our civilization's energy use to Space (otherwise the waste heat will make the Earth uninhabitable, [7]). Server farms in orbit are the likely first candidate: they would be ideally placed for solar power utilization, waste heat dumping, and uninterrupted networking. Mobilizing resources to relocate computing power to space may not only gain a decisive short-term advantage, but also lay foundation for the long-term trend: settling space while managing Earth as a model nature preserve, heritage site and vacation spot for the future generations of human space settlers.

Space development options critically depend on ethics. The currently dominant space access technology, chemical rocketry, is fundamentally handicapped by the rocket equation: the payload to LEO is between 3% and 5% of the fueled weight on the launchpad. The rest is waste. Even at the present modest cadence of 330 launch attempts in 2025, the space industry's environmental burden is considerable—both in atmospheric pollution and orbital debris [71]. The latter can lock humans out of space for centuries due to Kessler syndrome: an avalanche increase in orbiting hypervelocity projectiles through satellite collisions. Meantime, the urgently needed orbital cleanup, while approaching technical feasibility [72], lacks the legal basis to become a practical tool. Deorbiting debris without its owner's authorization (and that of other parties whose space assets may be endangered by such mission) was not even a consideration for 1967 Outer Space Treaty. Its central provision of "due regard" for legitimate interests of other parties failed the reality test [73]. The Artemis Accords of 2020 [74] are so far not signed by either China or Russia; both have expressed unease about the "safety zones" that are supposed to exclude competitors from some area on another celestial body. The Artemis Accords put the responsibility for deorbiting defunct satellite at the end of its useful life on its owner. While this is a radical improvement over the 1967' Outer Space Treaty, it might be more cost-effective to use specialized services—especially in the case of small satellites and unclaimed debris. Under a cooperative legal regime, such services could address the issues of existing debris and deorbit failures. None of this is possible without the ethics of collaboration and trust.

On Earth, reducing the space industry's environmental footprint and enabling a radical increase in its payload capacity appears technically feasible using a variety of non-rocket launch approaches. Some of these require materials of dubious feasibility (such as a defect-free single-crystal graphene sheet 50,000 km long for a space elevator). The more realistic versions, such as a launch loop [75] that can be entirely constructed from existing materials using well understood technologies, are large structures preferably constructed over water at the equator. A human-rated launch loop would be an about 2000-km long, due to the need to limit the acceleration to that comfortably survivable by humans. For unmanned payloads, this would relax the hardening requirements, increasing the efficiency of the operation. Again, creating infrastructure on this scale requires the ethics of international collaboration and trust.

6. Conclusion: Evolutionary Ethics in the Pursuit of Collective Immortality

The cumulative cultural evolution of humans involves making deliberate choices at an increasing scale. Current efforts to sustainably manage global energy, climate, water and space access, environment and labor appear inadequate to sustain human civilization beyond the short fossil-fueled spurt. The necessary resources (labor, minerals, technology, finance), while available in principle, cannot be committed at the scale needed for sustained development without significantly improved decision-making [62, 76]. Unsatisfactory decision-making process, and in particular its ethical foundations, appear to have become an existential risk to the global human civilization.

The increasingly urgent problem of technological unemployment is a good illustration of this risk. With steady productivity increases through robotics, humans can't stay gainfully employed without developing new ambitions robots can't meet. This has led to the paradoxical situation when affluent societies with the best resource availability to meet humanity's next challenges (such as sustainable space access, sustainable energy transition etc.) instead see the employment opportunities disappear. The desire to protect one's livelihood in a shrinking labor market favors xenophobic sentiment and the populist "they steal our jobs" rhetoric [77]. Meanwhile, a commitment to invest appropriate resources in the future (global power grid, environmental cleanup, water management infrastructure, sustainable space access) would create enormous labor demand, mostly in the fields where supremely adaptable humans far outperform robots. Such irrational goal-setting would be similar in spirit to the investment choices made by our ancestors in the past, from tinkering with rocks and sticks to make a rock-tipped spear to Nabta Playa observatory to Mesopotamian irrigation systems to Moon landings. The pride in "human identity"—the past accomplishments and the information accumulated from them (and the far more numerous failures)—may help choose taking on a next, bigger challenge. It is a part of human heritage to "commit before certainty": to support those trying various innovations on an increasing scale, and share the risk and reward with them.

The Northern and Southern cultures are (among other things) competing approaches to organizing this risk-sharing in a society. Currently, and alarmingly, the global North appears to adopt a generally risk-averse attitude. For example, it takes an average of 29 years to open a mining operation in the United States; the burden of proof is on the mining companies which "must go through a lengthy and detailed process to show they have adequately considered and mitigated the potential impacts" [78]. The perspective here is parallel to seeking to justify a moratorium on deliberate panspermia [27] "until we can predict... long-term outcomes". Nobody appears to carry the burden of proof that they have adequately considered and mitigated the potential impacts of refusal to develop the mines, or to spread life beyond Earth. It might be useful to consider a moratorium on such moratoria until we can predict their long-term outcomes. The risks of risk-aversion have been pointed out, for example in the case of FDA-regulated vaccine development [79]. However, it took a global emergency—the COVID pandemic—to change the mindset at the FDA to enable vaccine development and deployment in 11 months instead of 10–15 years [80]. The decisive response to the pandemic helped to limit the death toll attributable to COVID to 0.2% of the global population [81]. The coming energy crisis will likely be far more severe: fossil fuels account for 82% of our energy, and in 30–40 years extracting oil and gas will cost as much energy as they contain. The last time we used 82% less energy than we are using now, around 1950, global human population was not 0.2% smaller than today, but 68% smaller. Unavailability of energy to support a majority of humans can't fail to have catastrophic consequences for human civilization—and the current rate of investment in transition to renewables is many times lower than that needed to complete the transition in 40 years [62]. Committing adequate resources to this transition will largely determine the likelihood of our civilization's survival beyond the short fossil-fueled burst.

This commitment demonstrably depends on human ethics. Assertive panbiotic ethics supporting positive self-image of humanity as an emerging terrestrial guardian—and eventually extraterrestrial gardener—may lead to sufficient public support to make it possible. It may help avert the energy crisis (and ensuing collapse of the global civilization) by going 100% renewable while we still have the energy from fossil fuels to invest in doing so. It may also help remove the anxieties over "useless humans", invest their talent and ambition in taking care of the Earth and settling space, and reroute international competition from isolationism, protectionism and mutual sabotage to a constructive, collaborative path. It may help avert the looming human population collapse before depopulation spreads and becomes global and unstoppable. Humans tend to feel better about themselves when they are needed and valued; they are more interested in education, entrepreneurship, forming families, having children, participating in all aspects of society. Assertive life-centered, panbiotic ethics of terrestrial guardianship and extraterrestrial gardening has the "side benefit" of providing a rationale to keep billions of people gainfully employed for many centuries—doing noble, meaningful work and feeling good about themselves, each other, and future generations. Accepting such an ethical paradigm appears to be a selection criterion for civilizations to develop beyond planetary stage (that human civilization currently is at) and eventually help spread life beyond their home planet.

Funding

This research received no external funding.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

All data used in this work are presented in the paper and in cited from related references.

Acknowledgments

The author is deeply grateful to James Dator, John Smart, Olga Shenderova, Ken Baskin, Isaac Arthur, John Stewart, Eugene Shenderov, Christopher Mason, Tom Lombardo, Santosh Madhava Warrier and two anonymous reviewers for their encouragement and constructive critique.

Conflicts of Interest

The author declares that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Use of AI and AI-assisted Technologies

Not applicable.

References

1. Hume, D. *A Treatise Of Human Nature*; Mossner, E.C., Ed.; Penguin Books: London, UK, 1985; (Original work published 1739–1740).
2. Huxley, T.H. Evolution and ethics (1893). In *Evolution & Ethics and Other Essays*; London: Macmillan and Co.: London, UK, 1901; pp. 46–116
3. FitzPatrick, W.J. Morality and evolutionary biology. In *The Stanford Encyclopedia of Philosophy*, Fall 2025 edn.; Zalta, E.N.; Nodelman, U., Eds.; Stanford, CA, USA: Metaphysics Research Lab, Stanford University: Stanford, CA, USA, 2025. Available online: https://plato.stanford.edu/archives/fall2025/entries/morality-biology/ (accessed on 14 June 2026).
4. Rakos, R.; Rehfeldt, R.; Killeen, P. The free will: Determinism debate in contemporary science and society (Or: Why Are You Reading This Article?) *Perspect. Behav. Sci.* **2025**, *48*, 475–497. https://doi.org/10.1007/s40614-025-00447-3
5. Darwin, C. *The Descent of Man, and Selection in Relation to Sex*; John Murray: London, UK, 1871.
6. Wolpert, D.H. Physical limits of inference. *Phys. D Nonlinear Phenom.* **2008**, *237*, 1257–1281. https://doi.org/10.1016/j.physd.2008.03.040
7. Shenderov, A. *Homo Exploratoris: Is Humanity An Apprentice God?*; SacraSage Press: Durham, NC, USA, 2022.
8. Sagan, C. *Cosmos*; Random House: New York, NY, USA, 1980.

9. Smolin, L. Did the Universe evolve? *Class. Quantum Grav.* **1992**, *9*, 173–191. https://doi.org/10.1088/0264-9381/9/1/016
10. Smart, J.M. Cosmological natural selection (fecund universes). Evo Devo Universe Wiki. Available online: https://evodevouniverse.com/wiki/Cosmological_natural_selection_(fecund_universes) (accessed on 14 June 2026).
11. Zubrin, R.; Gilster, P. Artificial Singularity Power: A Basis For Developing And Detecting Advanced Spacefaring Civilizations. Available online: https://www.centauri-dreams.org/2019/10/17/artificial-singularity-power-a-basis-for-developing-and-detecting-advanced-spacefaring-civilizations/ (accessed on 14 June 2026).
12. Gardner, J.N. The selfish biocosm: Compexity as cosmology. *Complexity* **2000**, *5*, 34–45. https://doi.org/10.1002/(SICI)1099-0526(200001/02)5:3<34::AID-CPLX7>3.0.CO;2-8
13. Vidal, C. *The Beginning and the End: The Meaning of Life in a Cosmological Perspective*; Springer: New York, NY, USA, 2014.
14. Price, M. Could Cosmological Natural Selection Assign a Function to Life? Available online: https://www.prosocial.world/posts/could-cosmological-natural-selection-assign-a-function-to-life (accessed on 18 May 2026).
15. Price, M. Cosmological natural selection and the function of life. In *Evolution, Development and Complexity*; Georgiev, G.; Smart, J.; Flores Martinez, C.; et al., Eds.; Springer Proceedings in Complexity; Springer: Cham, Switzerland, 2019.
16. Marshall, M. Life Happened Fast. 2025. Available online: https://aeon.co/essays/life-on-earth-emerged-fast-far-quicker-than-we-thought (accessed on 18 June 2026).
17. Caldeira, K.; Kasting, J. The life span of the biosphere revisited. *Nature* **1992**, *360*, 721–723. https://doi.org/10.1038/360721a0
18. Napier, W.M. A mechanism for interstellar panspermia. *Mon. Not. R. Astron. Soc.* **2004**, *348*, 46–51. https://academic.oup.com/mnras/article/348/1/46/1415892
19. Cleaves II, H.J.; Butch, C.; Burger, P.B.; et al. One among millions: The chemical space of nucleic acid-like molecules. *J. Chem. Inf. Model.* **2019**, *59*, 4266–4277. https://doi.org/10.1021/acs.jcim.9b00341.
20. Zubrin, R. *The Case for Space*; Prometheus Books: New York, NY, USA, 2019; pp. 158–159.
21. Shapiro, J.A. Thinking about bacterial populations as multicellular organisms. *Annu. Rev. Microbiol.* **1998**, *52*, 81–104. https://doi.org/10.1146/annurev.micro.52.1.81
22. Meadows, R. A social amoeba discriminates in favor of kin. *PLoS Biol.* **2008**, *6*, e290. https://doi.org/10.1371/journal.pbio.0060290
23. Voorhees, B.; Read, D.; Gabora, L. Identity, kinship, and the evolution of cooperation. *Curr. Anthropol.* **2020**, *61*, 194–218. https://doi.org/10.1086/708176
24. Henrich, J.; Henrich, N. Culture, evolution and the puzzle of human cooperation. *Cogn. Syst. Res.* **2006**, *7*, 220–245. https://doi.org/10.1016/j.cogsys.2005.11.010
25. Stewart, J. The meaning of life in a developing universe. *Found. Sci.* **2010**, *15*, 395–409. https://doi.org/10.1007/s10699-010-9184-9
26. Carroll, S. *A Series of Fortunate Events: Chance and the Making of the Planet, Life, and You*; Princeton University Press: Princeton, NJ, USA, 2020.
27. Soryl, A.; Sandberg, A. To seed or not to seed: Estimating the ethical value of directed panspermia. *Acta Astronaut.* **2025**, *232*, 397–404. https://doi.org/10.1016/j.actaastro.2025.03.025
28. Gintis, H. The evolution of human cooperation (with comment). *Cliodynamics* **2012**, *3*, 172–190. https://doi.org/10.21237/C7clio3112928
29. Kelly, R.C. *The Nuer Conquest*; University of Michigan: Ann Arbor, MI, USA, 1985.
30. Lasco, G. *Did Margaret Mead Think a Healed Femur Was the Earliest Sign of Civilization?*; SAPIENS: New York, NY, USA, 2022. Available online: https://www.sapiens.org/culture/margaret-mead-femur/ (accessed on 13 May 2026).
31. Bronstein, J.L.; Shuster, S.H. Connecting and integrating cooperation within and between species. *Philos. Trans. R. Soc. B* **2024**, *379*, 1909. https://doi.org/10.1098/rstb.2023.0203
32. Nicolau Jr., D.V.; Armitage, J.P.; Maini, P.K. Directional persistence and the optimality of run-and-tumble chemotaxis. *Comput. Biol. Chem.* **2009**, *33*, 269–274. https://doi.org/10.1016/j.compbiolchem.2009.06.003
33. Ortega, B.A.D.; Huang, A.; Oikonomou, C.; et al. Structural conservation of chemotaxis machinery across Archaea and Bacteria. *Environ. Microbiol. Rep.* **2015**, *7*, 414–419. https://doi.org/10.1111/1758-2229.12265
34. Jee, J.; Rasouly, A.; Shamovsky, I.; et al. Rates and mechanisms of bacterial mutagenesis from maximum-depth sequencing. *Nature* **2016**, *534*, 693–696. https://doi.org/10.1038/nature18313
35. Gibson, B.; Wilson, D.; Feil, E.; et al. The distribution of bacterial doubling times in the wild. *Proc. Biol. Sci.* **2018**, *285*, 20180789. https://doi.org/10.1098/rspb.2018.0789
36. Chernetsov, U.G.; Chernetsov, N.B. Do first-time avian migrants know where they are going: The clock-and-compass concept today. *Front. Physiol.* **2025**, *16*, 1562569. https://doi.org/10.3389/fphys.2025.1562569
37. Malville, J.; Schild, R.; Wendorf, F.; et al. Astronomy of Nabta Playa. In *African Cultural Astronomy*; Springer: New York, NY, USA, 2008, pp. 131–143.
38. Overmann, K.A. The material difference in human cognition, *Adapt. Behav.* **2021**, *29*, 123–136. https://doi.org/10.1177/105971232093073
39. Lahiff, N.J.; Clay, Z.; Epping, A.J.; et al. Conspecific alarm calls, but not food-associated calls, elicit affect-based and object-based mental representations in a bonobo (Pan paniscus). *R. Soc. Open Sci.* **2025**, *12*, 241901. https://doi.org/10.1098/rsos.241901
40. Pruetz, J.D.; Bertolani, P. Savanna Chimpanzees, Pan troglodytes verus, Hunt with Tools. *Curr. Biol.* **2007**, *17*, 412–417. https://doi.org/10.1016/j.cub.2006.12.042
41. Sasaki, T.B.D. Cumulative culture can emerge from collective intelligence in animal groups. *Nat. Commun.* **2017**, *8*, 15049. https://doi.org/10.1038/ncomms15049
42. Semaw, S.; Rogers, M.J.; Quade, J.; et al. 2.6-Million-year-old stone tools and associated bones from OGS-6 and OGS-7, Gona, Afar, Ethiopia. *J. Hum. Evol.* **2003**, *45*, 169–177. https://doi.org/10.1016/S0047-2484(03)00093-9
43. Adler, D.; Wilkinson, K.; Blockley, S.; et al. Early levallois technology and the transition from the lower to middle palaeolithic in the Southern Caucasus. *Science* **2014**, *345*, 1609–1613. https://doi.org/10.1126/science.1256484
44. Wilkins, J.; Schoville, B.; Brown, K.; et al. Evidence for early hafted hunting technology. *Science* **2012**, *338*, 942–946. https://doi.org/10.1126/science.1227608
45. Muthukrishna, M.; Henrich, J. Innovation in the collective brain. *Philos. Trans. R. Soc. B* **2016**, *371*, 20150192. https://doi.org/10.1098/rstb.2015.0192
46. Mesoudi, A.; Thornton, A. What is cumulative cultural evolution? *Proc. Biol. Sci.* **2018**, *285*, 20180712. https://doi.org/10.1098/rspb.2018.0712
47. Oktaviana, A.; Joannes-Boyau, R.; Hakim, B.; et al. Narrative cave art in Indonesia by 51,200 years ago. *Nature* **2024**, *631*, 814–818. https://doi.org/10.1038/s41586-024-07541-7
48. Bird, M.; Condie, S.; O'Connor, S.; et al. Early human settlement of Sahul was not an accident. *Sci. Rep.* **2019**, *9*, 1–10. https://doi.org/10.1038/s41598-019-42946-9
49. Bradshaw, C.; Ulm, S.; Williams, A.; et al. Minimum founding populations for the first peopling of Sahul. *Nat. Ecol. Evol.* **2019**, *3*, 1057–1063. https://doi.org/10.1038/s41559-019-0902-6

50. Liu, C.; Shi, R.; Zhang, Y.; et al. 2015 How large land areas, and how long of shorelines in the world—Vector data based on google earth images. *J. Glob. Chang. Data Discov.* **2020**, *3*, 124–147.
51. Henrich, J. *The WEIRDest People in the World: How the West Became Psychologically Peculiar and Particularly Prosperous*; Farrar, Straus and Giroux: New York, NY, USA, 2020.
52. Boden, M.A. Optimism. *Philosophy* **1966**, *41*, 291–303. https://doi.org/10.1017/S0031819100058848
53. Roser, M.; Ritchie, H. Optimism and Pessimism. Available online: https://archive.ourworldindata.org/20251125-173858/optimism-and-pessimism.html (accessed on 31 May 2026).
54. IEA. *Electricity Grids and Secure Energy Transitions*; IEA: Paris, France, 2023.
55. Statista, Electric Transmission Projects Completed in the United States from 2019 to 2024, by Voltage. Available online: https://www.statista.com/statistics/551519/us-line-length-of-electricity-transmission-projects-completed/ (accessed on 10 May 2025).
56. Slater, M.D. Reinforcing spirals model: Conceptualizing the relationship between media content exposure and the development and maintenance of attitudes. *Media Psychol.* **2015**, *18*, 370–395. https://doi.org/10.1080/15213269.2014.897236
57. Mastroianni, A.G.D. The illusion of moral decline. *Nature* **2023**, *618*, 782–789. https://doi.org/10.1038/s41586-023-06137-x
58. Pew Research Center. Trust and Distrust in America. Available online: https://www.pewresearch.org/internet/2019/07/22/trust-and-distrust-in-america/ (accessed on 7 June 2026).
59. Ratuva, S. The politics of imagery: understanding the historical genesis of Sinophobia in Pacific Geopolitics. *East Asia* **2022**, *39*, 13–28. https://doi.org/10.1007/s12140-021-09376-9
60. Bazian, H. Islamophobia, “Clash of Civilizations”, and Forging a Post-Cold War Order! *Religions* **2018**, *9*, 282. https://doi.org/10.3390/ rel9090282
61. North Atlantic Treaty Organization. Defence Expenditures and NATO’s 5% Commitment. Available online: https://www.nato.int/en/what-we-do/introduction-to-nato/defence-expenditures-and-natos-5-commitment (accessed on 13 June 2026).
62. Shenderov, A. Powering human civilization beyond the fossil fuels era. *Earth Syst. Resour. Sustain.* **2026**, *1*, 320–331. https://doi.org/10.53941/esrs.2026.100019
63. Goldthau, A.; Sitter, N. Horses for courses. The roles of IPE and Global Public Policy in global energy research. *Policy Soc.* **2021**, *40*, 467–483. https://doi.org/10.1080/14494035.2021.1975216
64. Schneider, J.; Peeples, J. The energy covenant: Energy dominance and the rhetoric of the aggrieved. *Front. Commun.* **2018**, *3*, 5. https://doi.org/10.3389/fcomm.2018.00005
65. Docquier, F.; Rapoport, H. The vicious circle of xenophobia: Immigration and right-wing populism. In *Working Papers 2025–06*; CEPII Research Center: Paris, France, 2025.
66. Jarvis, S. The economic costs of NIMBYism: Evidence from renewable energy projects. *J. Assoc. Environ. Resour. Econ.* **2025**, *12*, 983–1022. https://doi.org/10.1086/732801
67. Ujomu, P. ‘Ubuntu’ Ethical Perspective and the Global Order. *Methexis, J. Res. Val. Spiritual.* **2025**, *2*, 67–109. https://doi.org/10.71210/mjrvs.3.a.5
68. Nie, J.-B. Confucian ethics of Xin (trust) and practical idealism: Reorienting world order beyond Western realist international relations. *Front. Commun.* **2026**, *10*, 1680442. https://doi.org/10.3389/fcomm.2025.1680442
69. Baggio, G.; Qadir, M.; Smakhtin, V. Freshwater availability status across countries for human and ecosystem needs. *Sci. Total Environ.* **2021**, *792*, 148230. https://doi.org/10.1016/j.scitotenv.2021.148230
70. You, X. China leads research in 90% of crucial technologies — A dramatic shift this century. *Nature* **2026**, *649*, 13–14. https://doi.org/10.1038/d41586-025-04048-7
71. Bahman, N.; Naser, N.; Hussain, M. A systematic review of the space industry’s environmental burden within earth system limits. *J. Environ. Earth Sci.* **2026**, *8*, 88–101. https://doi.org/10.30564/jees.v8i4.13010
72. Hou, C.; Yang, Y.; Yang, Y.; et al. Electromagnetic-launch-based method for cost-eflcient space debris removal. *Open Astron.* **2020**, *29*, 94–106. https://doi.org/10.1515/astro-2020-0016
73. Schrogl, K.-U. *“Due Regard” in Outer Space – A Lost Cause?* Geneva Centre for Security Policy: Geneva, Switzerland, 2026.
74. NASA. The Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids for Peaceful Purposes. Available online: https://www.nasa.gov/wp-content/uploads/2022/11/Artemis-Accords-signed-13Oct2020.pdf?emrc=6a2ebd69089cc (accessed on 14 June 2026).
75. Lofstrom, K.H. The launch loop–a low cost Earth-to-high orbit launch system. In *AIAA Paper 85-1368*; American Institute of Aeronautics and Astronautics (AIAA): New York, NY, USA, 1985.
76. United Nations DESA. *The Sustainable Development Goals Report 2025*; DESA Publications: New York, NY, USA, 2025.
77. Chinomona, E.; Maziriri, E. Examining the Phenomenon of Xenophobia as Experienced by African Immigrant Entrepreneurs in Johannesburg, South Africa: Intensifying the Spirit of “Ubuntu”. *Int. J. Res. Bus. Stud. Manag.* **2015**, *2*, 20–31.
78. Russell, T.; Jenkins, M. 29 years to Abundance: Why US Mines Never Open. Available online: https://pacificlegal.org/wp-content/uploads/2026/05/SR-1571-Jenkins-and-Russell-Research-in-Brief-Permitting-Reform-for-US-Mining-v1.pdf (accessed on 15 June 2026).
79. Miller, H.I.; Henderson, D.R. The FDA’s Risky Risk-Aversion. Available online: https://www.hoover.org/research/fdas-risky-risk-aversion (accessed on 15 June 2027).
80. Burgos, R.; Badowski, M.; Drwiega, E.; et al. The race to a COVID-19 vaccine: Opportunities and challenges in development and distribution. *Drugs Context* **2021**, *10*, 1–10. https://doi.org/10.7573/dic.2020-12-2
81. Jha, P.; Brown, P.; Ansumana, R. Counting the global COVID-19 dead. *Lancet* **2022**, *399*, 1937–1938. https://doi.org/10.1016/S0140-6736(22)00845-5