Rethinking the 'Heritage of Humanity' in the Anthropocene: Gene Editing, Biosphere Modification, and the Need for a Novel Entities International Legal Framework

Senior lecturer **Chamundeeswari KUPPUSWAMY**[1]

Abstract

This paper aims to analyse the implications of technology of gene editing on the scope and meaning of the legal concept of the heritage of humanity in the context of the wider phenomenon of the Anthropocene. Therefore, the objectives of this paper are two-fold; first, does the concept of heritage of humanity allow gene editing to modify this heritage? Secondly, given that humans can modify not just the human genome, but genomes of other life using the new gene editing technologies, how should non-human genetic manipulation on larger and faster scales be governed? This paper uses the doctrinal research method to investigate international bio-law using interdisciplinary concepts from earth systems science. The analysis draws attention to the weak framework of existing international law, and the acceleration of the Anthropocene biosphere, which in turn pushes the earth out of the safe operating zone. This paper calls for regulating gene editing through an international policy and legal framework for novel entities, rethinking the concept of the 'heritage of humanity' as going beyond the human genome.

Keywords: *common heritage; human genome; gene editing; novel entities; planetary boundaries; universal declaration on the human genome*

JEL Classification: K33

DOI: 10.62768/TBJ/2025/15/3/02

Please cite this article as:	**Article History**
Kuppuswamy, Chamundeeswari, 'Rethinking the 'Heritage of Humanity' in the Anthropocene: Gene Editing, Biosphere Modification, and the Need for a Novel Entities International Legal Framework', *Juridical Tribune – Review of Comparative and International Law* 15, no. 3 (October 2025): 447-460.	Received: 25 May 2025 Revised: 20 September 2025 Accepted: 07 October 2025

1. Introduction

The advent of powerful gene editing technologies, most notably the 'clustered regularly interspaced short palindromic repeats' (CRISPR-Cas) system, has led to a re-evaluation of humanity's relationship with the natural world and, with its own biological identity. CRISPR-Cas9, with its precision, affordability, and accessibility, has transformed the discipline of genetic engineering into a mainstream tool for altering the fundamental code of life[2]. This technological leap presents a legal and ethical challenge,

[1] Chamundeeswari Kuppuswamy - Hertfordshire Law School, University of Hertfordshire, United Kingdom, c.kuppuswamy@herts.ac.uk, https://orcid.org/0000-0002-2226-5240.

[2] Doudna, J. A., & Charpentier, E. (2012). The new frontier of genome engineering with CRISPR-Cas9.

pushing the boundaries of existing international frameworks. Central to this challenge is the concept of the 'heritage of humanity', a principle in international law, intended to safeguard shared resources for all generations. While traditionally applied to extraterrestrial spaces such as the moon and outer space, and the deep seabed, the concept has been applied to the human genome in the 1997 Universal Declaration on the Human Genome and Human Rights.

This paper aims to analyse the implications of this new technology on the legal concept of the heritage of humanity within the context of a wider phenomenon: the Anthropocene. The Anthropocene, a proposed new geological epoch, signifies a period in which human activity has become the dominant driver of global environmental change, fundamentally altering Earth's systems[3]. From climate change to biodiversity loss, humanity's influence is now a geological force, shaping geophysical systems. Gene editing represents a new power to redesign it. This paper argues that the existing international legal frameworks are ill-equipped to govern this power, suffering from a weak and fragmented framework that fails to account for the planetary-scale implications of genetic modification.

The objectives of this paper are two-fold. First, it analyses whether the legal concept of the heritage of humanity, as currently conceived, allows gene-editing to modify this heritage. This analysis focuses particularly on the human genome, often described as the common heritage of humanity. Secondly, this study extends the inquiry beyond the human genome to address the broader issue of non-human genetic manipulation. Given that humans can now modify not just their own genome but also the genomes of other life forms, from bacteria to elephants, on larger and faster scales than ever before, this study asks how such modifications should be governed. The analysis draws on the interdisciplinary insights of Earth systems science to demonstrate how gene editing pushes the Earth out of its safe operating space, particularly with regard to biosphere integrity.[4] While several previous analyses have debated the ethics and legality of gene-editing, this paper, for the first time, considers it within the context of the Anthropocene.[5]

Using doctrinal research method, this paper critically examines international

Science, 344(6184), 819–822; Ormond, K. E. et al. (2017). Human Germline Genome Editing. *The American Journal of Human Genetics*, Vol 101, 167–176.

[3] Crutzen, P. J., & Stoermer, E. F. (2000). The "Anthropocene". *Global Change Newsletter*, 41, 17–18.

[4] Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E. F., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., Nykvist, B., de Wit, C. A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R. W., Fabry, V. J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., & Foley, J. (2009). A safe operating space for humanity. *Nature*, 461(7268), 472–475.

[5] Jasanoff, S. (2016). A new biopolitics of genomes? *Nature* News, 531(7595), 419–421; Lanphier, E., Urnov, F., et al. (2015). Don't edit the human germ line. *Nature,* 519(7544), 410–411; Musunuru, K. (2017). Ethical issues in gene editing. *American Journal of Bioethics,* 17(1), 1-13; Verschuuren, J. (2020). The Precautionary Principle in International Law: The Case of the Cartagena Protocol on Biosafety. *Journal of Environmental Law,* 32(3), 503–526; Knoppers, B. M., & Chadwick, R. (1994). The Human Genome Project: under a cloud of patents and private interests. *Journal of Law, Medicine & Ethics,* 22(1), 16–22; Doudna, J. A. & Sternberg, S. H. (2017). *A Crack in Creation: Gene Editing and the Unthinkable Power to Control Evolution.* Houghton Mifflin Harcourt.

bio-law, including treaties, declarations, and customary norms. It reveals the limitations of frameworks designed in an era before widespread, precise, and inexpensive genetic modification was a reality. The analysis reveals a significant regulatory gap and calls for a new, cohesive international legal framework for novel entities and processes that can reshape the biosphere. This new framework, which this study proposes as a hybrid solution, must be grounded in principles of planetary stewardship and intergenerational equity, but its application will be guided by a situation ethics evaluation, ensuring that decisions are made on a case-by-case basis to achieve the most loving and beneficial outcome for the living world.

2. The Concept of the 'Heritage of Humanity' and Its Application

The concept of the 'common heritage of mankind' (or humanity) (CHM) emerged in the mid-20th century as a foundational principle of international law, designed to manage resources and territories beyond national jurisdiction. It was a visionary response to the potential for unilateral exploitation of global commons. The principle posits that certain resources or territories belong to all of humanity and that their use should be for the benefit of all, with a special emphasis on developing nations. Its core tenets include non-appropriation, shared management, and peaceful use. This concept was first articulated by Malta's ambassador, Arvid Pardo, in his landmark 1967 speech to the UN General Assembly.[6]

The concept was first applied to two distinct domains: outer space and the deep seabed. The 1967 Outer Space Treaty, for example, declared that outer space, including the Moon and other celestial bodies, is 'not subject to national appropriation by claim of sovereignty'.[7] While it stopped short of explicitly using the phrase 'common heritage', the treaty embodied its spirit by promoting the exploration and use of space for the 'benefit and in the interests of all countries'[8]. The 1979 Moon Treaty went further, explicitly designating the Moon and its natural resources as the 'common heritage of mankind'.[9]

The most detailed and significant application of the concept is found in the 1982 United Nations Convention on the Law of the Sea (UNCLOS)[10]. Part XI of UNCLOS establishes a legal regime for the Area, defined as the seabed and ocean floor and subsoil thereof beyond the limits of national jurisdiction. Article 136 of UNCLOS states that 'the Area and its resources are the common heritage of mankind'.[11] The treaty

[6] Pardo, A. (1967). *UN General Assembly, First Committee, 1515th Meeting, 1 November 1967*. Statement by the Maltese Ambassador.

[7] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, opened for signature January 27, 1967, 610 U.N.T.S. 205 (entered into force October 10, 1967).

[8] Ibid.

[9] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, opened for signature December 18, 1979, 1363 U.N.T.S. 3 (entered into force July 11, 1984).

[10] United Nations Convention on the Law of the Sea, opened for signature December 10, 1982, 1833 U.N.T.S. 397 (entered into force November 16, 1994).

[11] Murase, S. (2017). The Common Heritage of Mankind Principle: From Outer Space and the Deep Seabed

establishes the International Seabed Authority as a legally binding framework that governs the Area by regulating resource exploitation for the benefit of all states. The application of the CHM principle to the global commons was driven by a concern over scarcity and exploitation. The goal was to prevent a 'first-come, first-served' race among technologically advanced nations that would exclude the rest of the world from benefiting from these valuable resources.[12]

However, the application of this concept to biological and genetic resources has been far more contentious and less successful. The human genome, in particular, has been a subject of intense debate. In 1997, UNESCO's Universal Declaration on the Human Genome and Human Rights declared that 'the human genome underlies the unity of all members of the human family, as well as the recognition of their inherent dignity and diversity. In a symbolic sense, it is the heritage of humanity'.[13] This declaration was a landmark moment, but it was carefully worded. The phrase 'in a symbolic sense' was a compromise to avoid creating a legally binding 'common heritage' regime that could challenge national sovereignty over genetic resources or the patenting of human genes.[14]

The key limitations of applying the traditional 'heritage of humanity' model to the human genome and the broader biosphere are twofold. First, the human genome is not a resource in the same way as mineral deposits on the seabed; it is the fundamental blueprint of our being, or the 'book of life'.[15] While the UNESCO Declaration aims to protect its integrity from commercialisation and eugenic practices, it does not explicitly prohibit its modification. The question of whether it *can* be modified is left open. The second, and more significant, limitation arises when considering the rest of life on Earth. The dominant legal framework for biological resources is not the 'common heritage' principle but the principle of national sovereignty. The Convention on Biological Diversity (CBD), for instance, affirms in Article 3 the 'sovereign right of States to exploit their own resources pursuant to their own environmental policies'.[16] This has led to a fragmented system where access to genetic resources is governed by bilateral agreements between nations, a far cry from a shared global stewardship model.[17]

This ambiguity in the scope of the term 'heritage of humanity' and the fragmentated governance of genetic material results in a structural weakness in the

to the Human Genome. *The Japanese Yearbook of International Law*, 60, 1–25.

[12] Robin R. Churchill and Alan V. Lowe, *The Law of the Sea*, 4th ed. (Manchester: Manchester University Press, 2020), 226–29.

[13] UNESCO. (1997). *Universal Declaration on the Human Genome and Human Rights*. Paris: UNESCO.

[14] Kuppuswamy, C. (2009). *The International Legal Governance of the Human Genome*. Routledge; Buttigieg, J. (2018). *The Human Genome as Common Heritage of Mankind: Reintroducing a Philosophical and Political Concept into Public Discourse*. Palgrave Macmillan.

[15] National Human Genome Research Institute, "Human Genome Project Completion: The Book of Life," NHGRI, April 2003, accessed September 17, 2025, https://www.genome.gov/11000196/human-genome-project-completion-the-book-of-life/.

[16] Convention on Biological Diversity, opened for signature June 5, 1992, 1760 U.N.T.S. 79 (entered into force December 29, 1993).

[17] Koivurova, T. (2019). The Fragmented International Law of Biodiversity Protection. *Review of European, Comparative & International Environmental Law*, 28(2), 173–182; Leary, D. K. (2007). *International Law and the Genetic Resources of the Deep Sea*. Brill.

existing international law on genetic resources. The heritage of humanity concept was forged to prevent exploitation of a shared, inert resource. Gene editing, however, involves the active modification of a dynamic, living system — the very fabric of life. This is not about who owns a resource, but who has the right to rewrite the genetic code that defines it.

3. The Anthropocene Biosphere: A New Context for Genetic Manipulation

The traditional legal frameworks discussed above were developed in an era when human activity, while impactful, was not yet seen as a dominant geological force. This perspective has been fundamentally challenged by the scientific consensus around the Anthropocene.[18] This concept, widely discussed in Earth systems science, posits that human activities — from industrialisation and deforestation to nuclear testing and now, genetic engineering — have pushed the Earth's systems outside the relatively stable Holocene state.[19] Gene editing is not merely another form of human impact; it is a new mode of biosphere modification, with implications that are both systemic and planetary in scale.

A key concept within Earth systems science is that of planetary boundaries, which defines a 'safe operating space for humanity'.[20] Crossing these boundaries significantly increases the risk of large-scale, abrupt, and irreversible environmental change. Two of these boundaries are significant in the context of gene editing. One of these boundaries is biosphere integrity, which includes both genetic diversity and functional diversity. This boundary is concerned with the erosion of the fundamental building blocks of life. Genetic diversity refers to the variety of genes within a species, and its loss is a direct consequence of extinction and population decline. When a species goes extinct, its unique genetic information is gone forever. Even within a species, if a population shrinks, it loses genetic variety, making it more vulnerable to disease and less able to adapt to environmental changes.

The other boundary is novel entities. This boundary is concerned with the introduction of entirely new biological entities into the environment. Novel entities include not just modified life forms, but also synthetic chemicals, plastics, and radioactive materials. Modified life forms specifically refers to organisms that have been engineered by humans, such as genetically modified crops or bacteria, that are then released into the biosphere. The concern is that these organisms have no natural evolutionary precedent and their long-term effects on ecosystems are unpredictable. The

---

[18] Paul J. Crutzen and Eugene F. Stoermer, "The 'Anthropocene'," *Global Change Newsletter* 41 (May 2000): 17–18.

[19] International Commission on Stratigraphy, *International Chronostratigraphic Chart*, v. 2023/09 (International Union of Geological Sciences, 2023), accessed September 17, 2025, https://stratigraphy.org/chart.

[20] Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E. F., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., Nykvist, B., de Wit, C. A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R. W., Fabry, V. J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., & Foley, J. (2009). A safe operating space for humanity. *Nature*, 461(7268), 472–475.

Earth's genetic diversity is the result of billions of years of evolution, a complex, self-organising system that provides the resilience and stability of the entire biosphere. Gene editing technologies now allow humanity to directly and rapidly intervene in this evolutionary process, not through slow, selective pressure, but through deliberate, targeted genetic alteration.

In species other than humans, selective breeding has been long in practice. But unlike, selective breeding, which takes generations to conduct, gene drives, for example, are a new application of gene editing that can force a specific genetic trait to spread through a population over generations, potentially with permanent and irreversible effects.[21] A gene drive could be designed to wipe out a species of mosquito to combat malaria or to eliminate an invasive species of rodent on an island. While the motives may be noble, the potential unintended consequences are immense and unpredictable. A gene drive could jump to a related species or have unforeseen cascading effects on the ecosystem, disrupting food webs and a delicate ecological balance.[22] These effects are not confined by national borders; a genetically modified insect could spread across continents, affecting the entire planet's genetic and functional diversity.

This capability constitutes a new form of human geological agency. It is a direct and deliberate modification of the fundamental components of the biosphere. The existing legal frameworks, such as the Cartagena Protocol on Biosafety, were designed to manage the risks of Living Modified Organisms (LMOs) on a case-by-case basis through national risk assessments.[23] They are entirely inadequate for the speed, scale, and potential for irreversible, trans-boundary effects posed by modern gene editing.[24] The current focus on a case-by-case risk assessment model is fundamentally flawed when dealing with systems-level changes. We are not just releasing a new crop variety; we are potentially altering the course of evolution for an entire species and its associated ecosystem.

This technological reality forces us to reconsider the meaning of the 'heritage of humanity'. If that heritage is not just the human genome but the entire living world, what are our obligations as its self-proclaimed stewards? The Anthropocene context demands a legal framework that moves beyond the logic of individual ownership or national sovereignty over biological resources. It requires a system that recognises humanity's collective responsibility for the health and integrity of the entire biosphere, the very system that supports all life. The question is no longer whether we *can* edit genes, but whether we *should*, and under what global ethical and legal authority.

---

[21] Esvelt, K. M., Smidler, A. L., C. C. Balagadde, & Collins, J. J. (2014). Concerning RNA-guided gene drives for the alteration of wild populations. *eLife*, 3, e03405.

[22] National Academies of Sciences, Engineering, and Medicine, *Gene Drives on the Horizon: Advancing Science, Navigating Uncertainty, and Charting a Research Path* (Washington, D.C.: National Academies Press, 2016), 119–30.

[23] Cartagena Protocol on Biosafety to the Convention on Biological Diversity, adopted January 29, 2000, 2226 U.N.T.S. 208 (entered into force September 11, 2003).

[24] Nuffield Council on Bioethics. (2016). *Genome editing: An ethical review*. Nuffield Council on Bioethics.

3.1. The Paradox of CRISPR's Natural Origins

The case of the powerful Clustered Regularly Interspaced Short Palindromic Repeats or CRISPR-Cas9 system is worthy of focus, to understand the conundrum that gene editing poses in the Anthropocene Biosphere. The CRISPR-Cas9 system is a revolutionary tool for gene editing, allowing scientists to precisely alter DNA sequences. It was inspired by a natural defense mechanism found in bacteria, which use it to fight off invading viruses. An analogy to the computing world would be that of the 'find and replace' function in a software: the CRISPR part is a guide that finds a specific target DNA sequence, and the Cas9 enzyme acts as molecular scissors to cut or modify that exact location. This precision makes it an incredibly powerful and versatile technology with wide-ranging applications in biology and medicine.

At its core, CRISPRis a brilliant piece of biomimicry. It is a biological tool that allows for precise, targeted gene editing, a technological marvel that humans have only recently harnessed. But this innovation didn't come from human invention; it came from a careful observation of bacteria. For billions of years, bacteria have used CRISPR-Cas systems as an elegant immune defense. When a virus invades, the bacterium captures a snippet of the virus's DNA and stores it. The next time the same virus attacks, the bacterium recognises the viral DNA and sends a special enzyme to cut and destroy it.

This natural, evolutionary solution to a fundamental biological problem served as the blueprint for our own gene-editing technology. It is a profound example of how nature, in its complexity and resilience, continues to be a wellspring of new, fresh ideas, providing the raw material for our most groundbreaking innovations.

3.2. The Anthropocene's Diminishing Returns

The core of this idea, however, is that this kind of natural inspiration may be running on a diminishing timeline. In the Anthropocene, humanity has become the single most powerful force shaping the planet. Our influence is no longer localised; it is global and systemic. We are changing atmospheric composition, altering land and water systems, and driving a massive wave of extinctions. As our footprint expands, the space for truly non-human processes contracts.

This creates a philosophical quandary: If we continue on this path, what will happen to the subtle, complex, and unpredictable non-human interactions that have long been our source of inspiration? The intricate dance between bacteria and viruses, the co-evolution of species, the novel mutations that occur in a truly wild state—these are the phenomena that have historically given us new ideas. But in an advanced state of the Anthropocene, where ecosystems are managed, genomes are known, and wild populations are highly diminished, there may be no more "fresh" ideas to be discovered. We might reach a point where we are left to innovate with what we have already discovered, or worse, with what we ourselves have created.

3.3. The Self-Referential Conundrum

This leads to a profound question about the future of genetic engineering. Should we consider using a tool like CRISPR to extensively manipulate animal, plant, and human genomes precisely because our source of natural inspiration is drying up?

From this perspective, the act of manipulating nature is no longer just about addressing specific problems like disease or crop yield. It becomes a matter of necessity — a way to compensate for the biological information that we, as a species, are extinguishing. In this view, we become the sole architects of future biological diversity, taking on the role of both creator and destroyer.

This is a new and challenging phenomenon. It forces us to confront whether we are ready to leave the realm of biomimicry and enter one of bio-engineering at a planetary scale. It asks if we can ethically and wisely manage a system where we are both the dominant influence and the primary source of innovation, or if this ultimate act of control risks creating a closed, fragile system that is less resilient than the one it replaced.

3.4. The Anthropocentric Impulse

The idea of using gene editing to change other organisms for human benefit is a powerful extension of an anthropocentric worldview, but it also raises a profound question of double jeopardy. This approach combines a human-centred attitude — where non-human life is primarily a resource to be optimized for our use — with a technology of unprecedented power, potentially creating a predicament that could be hugely detrimental to the human species itself.

Scientists are exploring ways to use gene-editing tools like CRISPR to alter the human microbiome to prevent diseases and enhance health, effectively treating our bodies as complex, modifiable ecosystems. At the same time, others are working on modifying the microbial communities in livestock to reduce methane emissions, offering a potential ‘techno-fix’ to a major driver of climate change. These applications are driven by an anthropocentric impulse: the belief that humanity's needs and well-being are of paramount importance, and that we have the right, and perhaps even the moral obligation, to manipulate nature to serve those needs. In this view, a cow's microbiome is not a natural system with its own integrity, but a biological factory to be re-engineered for greater efficiency in a human-dominated world.

3.5. The Double Jeopardy Conundrum

The ‘double jeopardy’ lies in the combination of this mindset with such a powerful tool.

The first jeopardy is the anthropocentric attitude itself. This is the same worldview that has historically led to the over-exploitation of resources, the disruption of ecosystems, and the current environmental crises we now face. It's the assumption that we can fully understand and control complex natural systems, a kind of

technological hubris that has often led to unforeseen consequences.

The second jeopardy is the sheer power of gene editing. While CRISPR offers remarkable precision, the biological systems we are targeting — like a gut microbiome or an entire ecosystem — are intricate, interconnected, and dynamic. Altering one variable for a desired outcome could set off unforeseen cascading effects that we are unable to predict or contain. It is likely that the engineered microbes in a cow's gut spread to wild ruminants, and our modified gut bacteria could lead to long-term dependencies or vulnerabilities we cannot anticipate. This combination is dangerous because it amplifies the risk of our flawed, human-centred worldview with a tool that can make those flaws a permanent part of the biosphere.

Ultimately, this endeavour asks a critical question: By continuing to view and manipulate the natural world as a means to an end, are we truly solving our problems, or are we just creating a new set of risks that could jeopardise our own long-term survival? The very tool we are using to 'fix' nature is an example of the kind of creative, non-human processes we are systematically eroding. In the absence of those natural influences, we may be doomed to a future of self-referential innovation, where our only source of new ideas is our own past actions — a cycle that could prove hugely detrimental to the human species.

4. The Weakness of the International Bio-Law Framework

An integrated doctrinal analysis of existing international legal instruments reveals a fragmented and inadequate framework for governing the age of gene editing. The current legal regime is a patchwork of non-binding declarations, sector-specific treaties, and national regulations that fail to address the systemic and planetary-scale challenges posed by the technology.

The 1997 UNESCO Universal Declaration on the Human Genome and Human Rights is a crucial starting point. By describing the human genome as the 'heritage of humanity', it established a foundational principle of non-commercialisation and protection from eugenic practices. Article 4 states, 'The human genome in its natural state shall not give rise to financial gain.' However, this declaration is non-binding, and its primary focus is the human genome, leaving the regulation of non-human genetic modification largely unaddressed. Its legal force is more persuasive than mandatory, relying on the moral suasion of the international community. However, it may be possible that the 1997 declaration, having been adopted unanimously could be the starting point for the formation of customary international law, which is binding in nature.[25]

The Convention on Biological Diversity (CBD) is the primary global legal instrument for the conservation and sustainable use of biodiversity. Its objectives are laudable, but its legal structure is ill-suited for the challenges of gene editing. A key weakness lies in its affirmation of national sovereignty over genetic resources, under Article 15.1. This framework was designed to address the bioprospecting of a nation's

[25] Malcolm N. Shaw, *International Law*, 8th ed. (Cambridge: Cambridge University Press, 2017), 79.

native species by foreign companies, ensuring fair and equitable sharing of benefits. However, it creates a significant barrier to a coordinated global response to technologies that do not respect national borders.[26] A gene drive released in one country could have irreversible effects on a neighbour's biodiversity, yet the governance is based on national control, not a shared global responsibility.

The Cartagena Protocol on Biosafety, a supplementary agreement to the CBD, was a significant step forward, focusing on the safe transfer, handling, and use of Living Modified Organisms (LMOs). It established a risk-assessment framework and the precautionary principle, allowing states to restrict LMO imports if scientific certainty about their safety is lacking. While valuable, this protocol is also limited. It was designed to manage the risks of specific, identifiable organisms, typically modified crops, and not to govern the broader processes of novel entity creation or technologies with systemic environmental effects. It does not adequately address the risks of gene drives, which are designed to spread aggressively through populations, or the development of entirely synthetic organisms that have no natural analogues. The focus on a case-by-case risk assessment is too slow and reactive for technologies that can be developed rapidly and have irreversible consequences on a planetary scale.[27]

The regulatory gaps are not merely a matter of technical details; the main legal frameworks need to transform. The existing frameworks are fragmented, with no single body or treaty having comprehensive oversight. They are primarily reactive, focusing on risk assessment after a new technology has been developed, rather than proactive, governing the creation and release of novel entities from the outset. They are also burdened by the principle of national sovereignty, which stands in direct opposition to the reality of the Anthropocene, where ecosystems and gene flow transcend political borders. The international legal system is caught in a legal paradox: it has established principles for shared stewardship of the cosmos and the oceans, yet it allows the fundamental components of life itself to be treated as national property, subject to a fragmented and inadequate governance system.

5. Towards a Legal Framework for a Co-Evolving Biosphere

The inadequacies of the current international legal framework necessitate a fundamental shift in our approach to governing gene editing and other forms of deliberate biosphere modification.[28] A new framework is required, one that moves beyond the fragmented, risk-based model and embraces a philosophy of planetary stewardship and co-evolutionary responsibility. This paper calls for the development of a comprehensive, new legal and policy framework for novel entities, grounded in an

[26] Tvedt, M. W. (2021). The Sovereign Right of States to Exploit their Own Genetic Resources: A Challenge for the International Law of Biodiversity. *Journal of International Economic Law*, 24(1), 147–170.
[27] Verschuuren, J. (2020). The Precautionary Principle in International Law: The Case of the Cartagena Protocol on Biosafety. *Journal of Environmental Law*, 32(3), 503–526.
[28] Ruhl, J. B. (2012). The Anthropocene as a Legal Challenge. *The Georgetown Law Journal*, 100(1), 1–44; O'Connell, M. E. (2016). The International Law of the Living Earth. *Georgetown Journal of International Law*, 47(4), 1083–1110.

expanded understanding of the 'heritage of humanity'.

The first step in this transformation is to legally and philosophically expand the concept of the 'heritage of humanity' to explicitly include the entire biosphere, not just the human genome. This would reframe the discussion from one of sovereign rights over a nation's resources to one of shared responsibility for a collective legacy. This principle would serve as the cornerstone for a new international legal regime, analogous to UNCLOS, but for the living world. It would establish that certain types of genetic modification, particularly those with a potential for planetary-scale, irreversible effects, are subject to a global, not national, jurisdiction.[29]

Secondly, this new framework must be based on a model of global governance of modification, rather than a reactive risk-assessment model. This would require the establishment of a global oversight body with the authority to regulate the creation and release of certain novel entities and technologies, such as gene drives or synthetic organisms designed to alter entire ecosystems. This body, perhaps a new international commission or an empowered arm of an existing institution, would operate on principles of intergenerational equity and the precautionary principle. It would be multidisciplinary, incorporating legal, ethical, and scientific expertise from Earth systems science to evaluate the potential for systemic effects before any release is sanctioned.[30]

The framework would need to develop new legal principles to govern these novel entities. Concepts such as 'genetic integrity' or 'biosphere stewardship rights' could be introduced. Genetic integrity would recognise the intrinsic value of natural evolutionary pathways and the right of future generations to inherit a biosphere not irreversibly altered by the current generation. Biosphere stewardship rights would be a collective right of all humanity, and perhaps other species, to a healthy and functional biosphere. These principles would be codified in a new international treaty, a 'Convention on Biosphere Integrity', that would be a parallel to the Law of the Sea or the Outer Space Treaty. This would be a move towards a 'global bio-regime'[31] that manages humanity's impact on the entire Earth System.

This new legal architecture would also need to address the practicalities of implementation, including compliance and enforcement mechanisms. Given the global and often diffuse nature of gene editing research and commercialisation, enforcement would rely on a combination of international cooperation, national legislation, and economic incentives. The treaty could include provisions for mandatory scientific review of high-risk technologies, a global registry of novel entities, and a system for benefit-sharing that extends to biological knowledge and intellectual property. It could also establish a global fund, financed by the biotechnology industry, to support biosafety research and to compensate states that suffer from accidental release. This would create a new legal and economic infrastructure to support the treaty's goals, moving from

---

[29] Bailie, T. (2017). The Biosphere as a Global Common: Regulating the Genetic Commons. *Journal of Environmental Law*, 29(1), 127–146.

[30] Gardiner, S. M. (2006). A Perfect Moral Storm: Climate Change, Intergenerational Ethics and the Problem of Moral Corruption. *Environmental Values*, 15(3), 397–413.

[31] Dryzek, J. S. (2005). *The Politics of the Earth: Environmental Discourses*. Oxford University Press.

aspirational principles to actionable global policy.

The challenges to implementing such a framework are immense. National sovereignty is a deeply ingrained principle in international law. Geopolitical tensions, a lack of trust between nations, and the immense commercial interests in biotechnology would all pose significant barriers. However, the stakes are equally immense. The power of gene editing, in the context of the Anthropocene, is a form of planetary-scale intervention. The questions are no longer abstract; they are urgent. We are not just deciding on the governance of a mineral resource or an empty space; we are deciding on the future of the living world itself. The existing legal frameworks, forged in a different era, offer no solution. The alternative is a future where humanity, in its quest for progress and control, fragments its shared heritage and irreversibly destabilises the very biosphere it depends upon for survival.

6. Conclusion

The technological revolution in gene editing has ushered in an era where humanity possesses the power to directly and deliberately alter the fundamental blueprint of life on Earth. This new capability, situated within the context of the Anthropocene, pushes the planet's systems to their limits, particularly with regard to biosphere integrity. The paper has used a doctrinal research method to demonstrate that the current international legal framework is inadequate to govern this power. The venerable concept of the ‘heritage of humanity’, while a powerful ideal, has been applied in a limited and inconsistent manner to the living world, while the dominant principle of national sovereignty has created a fragmented and ineffective legal landscape.

The 1997 Universal Declaration on the Human Genome is a non-binding moral compass that primarily addresses the human genome, leaving the broader biosphere in a regulatory void. Similarly, the Convention on Biological Diversity and its Cartagena Protocol are too slow, too fragmented, and too focused on a reactive, risk-based approach to deal with technologies like gene drives, which can have rapid and irreversible trans-boundary effects. The existing frameworks are relics of an era where humanity was not yet a geological force, and they fail to recognise that gene editing is an active and systemic intervention in the co-evolving processes of the biosphere itself. This paper concludes that a paradigm shift in international law is not only desirable but essential. We must move beyond the legal ambiguities and fragmentation that characterise the present regime. This requires a bold and visionary re-conception of the ‘heritage of humanity’ to explicitly include the entire biosphere, acknowledging it as a shared and sacrosanct legacy for all generations. This new principle should form the basis for a novel international legal framework that can effectively govern novel entities and processes. Such a framework must be global in scope, proactive in its approach, and grounded in the principles of planetary stewardship, intergenerational equity, and the recognition that we are co-evolving with, and have a profound responsibility for, the living world. The challenge is immense, but the alternative — a future of unchecked and irreversible genetic modification in a destabilising biosphere — is simply

untenable. Humanity must rise to the occasion, not just to protect the heritage it has inherited, but to consciously and responsibly steward the one it is now actively creating.

Bibliography

1. Bailie, T. (2017). The Biosphere as a Global Common: Regulating the Genetic Commons. *Journal of Environmental Law*, 29(1), 127–146.
2. Dryzek, J. S. (2005). *The Politics of the Earth: Environmental Discourses*. Oxford University Press.
3. Esvelt, K. M., Smidler, A. L., C. C. Balagadde, & Collins, J. J. (2014). Concerning RNA-guided gene drives for the alteration of wild populations. *eLife*, 3, e03405.
4. Gardiner, S. M. (2006). A Perfect Moral Storm: Climate Change, Intergenerational Ethics and the Problem of Moral Corruption. *Environmental Values*, 15(3), 397–413.
5. Nuffield Council on Bioethics. (2016). *Genome editing: An ethical review*. Nuffield Council on Bioethics.
6. Pardo, A. (1967). *UN General Assembly, First Committee, 1515th Meeting, 1 November 1967*. Statement by the Maltese Ambassador.
7. Tvedt, M. W. (2021). The Sovereign Right of States to Exploit their Own Genetic Resources: A Challenge for the International Law of Biodiversity. *Journal of International Economic Law*, 24(1), 147–170.
8. UNESCO. (1997). *Universal Declaration on the Human Genome and Human Rights*. Paris: UNESCO.
9. Verschuuren, J. (2020). The Precautionary Principle in International Law: The Case of the Cartagena Protocol on Biosafety. *Journal of Environmental Law*, 32(3), 503–526.
10. Convention on Biological Diversity. Opened for signature June 5, 1992. 1760 U.N.T.S. 79.
11. United Nations. Convention on the Law of the Sea. Opened for signature December 10, 1982. 1833 U.N.T.S. 397.
12. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies. Opened for signature January 27, 1967. 610 U.N.T.S. 205.
13. Churchill, Robin R., and Alan V. Lowe. *The Law of the Sea*. 4th ed. Manchester: Manchester University Press, 2020.
14. Agreement Governing the Activities of States on the Moon and Other Celestial Bodies. Opened for signature December 18, 1979. 1363 U.N.T.S. 3.
15. National Human Genome Research Institute. "Human Genome Project Completion: The Book of Life." NHGRI. April 2003. Accessed September 17, 2025. https://www.genome.gov/11000196/human-genome-project-completion-the-book-of-life/.
16. Crutzen, Paul J., and Eugene F. Stoermer. "The 'Anthropocene'." *Global Change Newsletter* 41 (May 2000): 17–18.
17. International Commission on Stratigraphy. *International Chronostratigraphic Chart*. v. 2023/09. International Union of Geological Sciences, 2023. Accessed September 17, 2025. https://stratigraphy.org/chart.
18. Cartagena Protocol on Biosafety to the Convention on Biological Diversity. Adopted January 29, 2000. 2226 U.N.T.S. 208.
19. National Academies of Sciences, Engineering, and Medicine. *Gene Drives on the Horizon: Advancing Science, Navigating Uncertainty, and Charting a Research Path*. Washington, D.C.: National Academies Press, 2016.

20. Shaw, Malcolm N. *International Law*. 8th ed. Cambridge: Cambridge University Press, 2017.