



Universal Laws, Particular Landscapes and Human Cultures Adaptation to Transforming Ecological Constraints

Abstract

The connection between ecology and human culture highlights a basic conflict between various cultural adaptations and universal biological limitations. The way that human societies respond to ecological principles, such as resource constraints, energy fluxes, and ecosystem interconnectedness, varies greatly depending on their belief systems, economic systems, and historical development. The present study investigated this dynamic interaction and made the case that an integrated strategy that recognises the uniqueness of human cultural frameworks as well as the universality of ecological principles is necessary for environmental sustainability. Using case studies ranging from industrialised environmental legislation to indigenous resource management, the paper illustrated how many communities use unique worldviews, customs, and technological advancements to navigate ecological boundaries. A biocultural perspective that unites ecological science and cultural relativism is promoted in place of reductionist methods that either overly heighten the idea that scientific knowledge and methods are applicable and valid across all cultures and contexts (universality of science) or ignore local knowledge. The paper's conclusive argument is that in order to effectively address global environmental crises, such as biodiversity loss and climate change, solutions must be both ecologically sound and culturally sensitive. Through the integration of multidisciplinary perspectives from sustainability studies, environmental humanities, and anthropology, this research advanced a more sophisticated comprehension of humanity's role in (and) obligation to nature.

Keywords: Human Culture, Universality, Sustainability, Biocultural Diversity, Environmental Adaptation.

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Introduction

To comprehend humanity's role in the natural world, it is essential to comprehend the relationship between ecology and human civilisation.

According to Begon, Townsend and Harper (2006), ecology examines the interactions between organisms, whereas human culture influences how communities perceive, use, and alter

their surroundings. We refer to human culture as things made up of the customs, institutions, common values, and tangible adaptations of various cultures. We consider that universal ecological laws (e.g., carrying capacity, nutrient cycles, and energy flows) exist, but human societies have diverse cultural responses to environmental challenges, raising questions about how these laws interact with culturally specific worldviews. This study contends that although ecological principles are universal, human cultural adaptations to the environment are distinct, resulting in a conflict between localised socio-cultural systems and shared biophysical facts. The study emphasises how important it is to look at environmental issues from both a culturally grounded perspective and a universal ecological framework.

The study challenges reductionist environmental narratives by advocating for a pluralistic approach that integrates ecological universals with cultural particulars, addressing crises like climate change, and assessing tensions between global environmental governance and local knowledge systems. We begin by (i) providing ecological principles affecting humanity, (ii) exploring cultural adaptation case studies, (iii) evaluating the tensions between global environmental governance and local knowledge systems, (iv) making a critical synthesis, and (v) drawing from (i) (ii) (iii) and (iv) to contribute to a deeper understanding of humanity's place in and responsibility to nature.

Universal Ecological Principles Affecting Human Culture

The basic guidelines that control how the natural world functions are known as ecological principles. Regardless of cultural context, universal ecological principles regulate the interaction between human civilisation and the natural world. These guidelines influence cultural adaptations and govern resource utilisation, survival, and long-term sustainability. Cohen-Shacham (2019) identified certain core universal ecological principles such as interconnectedness, energy flow, nutrient cycling, limiting factors and carrying capacity as well as succession and reliance. From this we can also draw out four fundamental ecological principles upon which human-environment interactions are based: reliance on biodiversity, adaptation to climate and geography, dependency on natural resources, and the increasing human influence on ecosystems in the anthropocene. It is vital to understand these principles because they are crucial for exploring the various ways that human cultures change and adapt to their surroundings, which is why this section concentrates on looking at them.

Unarguably, human societies depend on limited natural resources, such as food, energy, and water, to survive and function as a society. Similarly, agriculture, sanitation, and biological life all depend on water, while food security is a given and influences cultural practices across all eras, from contemporary agricultural systems to

nomadic hunter-gatherers. In the same vein, energy, which includes physical strength, fuels, and renewable resources, powers human activity and influences political power structures, economic systems, and cultural organisation. In essence, human populations are constrained by ecological factors (such as soil fertility, energy availability, and freshwater shortage) that cannot be changed. Dodds and Bartram (2016), Allouche, Middleton and Gyawali (2019) as well as Brouwer (2022) are some of the works that directly address these core ideas. All these point to the fact that cultural systems are essential for managing resource dependence because they impact how civilisations use or sustain their surroundings according to their ideals and technical advancements and (or) adjustments.

Cultural Particularities in Ecological Adaptation

Although human existence is guided by universal ecological principles, cultures create distinctive adaptations through subsistence techniques, built environments, economic systems, and cosmological beliefs. First, from high-intensity industry to low-impact foraging, human cultures have evolved a variety of subsistence techniques, each with its own consequences for sustainability. For instance, hunter-gatherer communities, such as the Kalahari Kung San, employ ecological knowledge to monitor seasonal resources and hunt wild foods in a sustainable manner, hence maintaining biodiversity (Lee & Hitchcock, 2001; Lee, 1979). This work acknowledges that

there are idealised accounts, however, which frequently ignore adaptive challenges, such as being uprooted from ancestral lands by conservation enclosures (such as national parks and game reserves), underscoring the tension between contemporary conservation initiatives and traditional hunter-gatherer cultures. Whereas traditional communities use renewable energy, industrialised cultures depend on fossil fuels. This cultural shifts in energy transitions, such as Iceland's geothermal energy vs Germany's engineering pragmatism that meets with rural resistance (Radtke, 2025), are highlighted by Smil (2017), who demonstrated how energy historiography frequently ignores cultural values influencing adoption rates. The point here is that energy adoption and transition are intertwined with a society's beliefs, values, and cultural narratives, necessitating a cultural shift or adjustment for successful transition.

Furthermore, ancient Mesopotamian irrigation systems and modern desalination technologies differ due to cultural priorities and technological capacities (Shiple, 2019; Solomon, 2010). For instance, Balinese Subak systems (Lansing & de Vet, 2012) synchronise planting with temple rituals, creating a hydrological democracy. In the same vein, American industrial agriculture relies on monocultures and synthetic inputs, sacrificing resilience for yield (Montgomery, 2017). For example, neoliberal policies in California's water markets exacerbate scarcity, disrupting

traditional knowledge (David & Hughes, 2024). This issue is currently ongoing in Mumbai's slums where the case is being made that water is a right (Bayliss & Deekshit, 2024) and that water scarcity prompts colonial undertones. Little wonder, Robbins (2012) challenged the Malthusian scarcity narrative, arguing that environmental issues are not caused by population growth, but by power imbalances, economic structures, and social inequalities, highlighting scarcity as a social construct.

Secondly, the climate and geography of the human environment have a significant impact on human civilisations. These elements influence survival tactics, ranging from farming methods to architectural designs, and they also impact the resources that are available (Nsamenang, 2015). For example, polar civilisations create items like snowshoes, whereas dry cultures create sophisticated irrigation systems. These illustrate how cultural creativity adjusts to environmental constraints. Today, these ancient systems are being upset by climate change, which forces society to develop new hybrid adaptations (Adger *et al.*, 2013). The Inuit culture (an indigenous circumpolar people inhabiting the Arctic and subarctic regions of North America and Russia, including parts of Greenland, Canada, Alaska, and Russia) is an example of a community that thrived through specific adaptations like igloo construction and seal-hunting, reflecting a deep connection to their environment. This symbiotic relationship is highlighted by their

traditional sea-ice knowledge, which views ice as a living entity that guides movement. In contrast, modern government (e.g., Canadian government) climate models treat ice as a mere hazard, creating policy that fails because it ignores this crucial relational understanding and the "dwelling perspective" of how people are embodied within their environment (Ford *et al.*, 2020; Raymond-Yakoubian & Daniel, 2022).

The Bedouin and other arid-region cultures, such as the Tuareg, equally developed complex adaptations like nomadic pastoralism and water-conservation techniques to survive in harsh climates. Chatty (2010) through the Bedouin discusses how nomadic pastoralism is a sophisticated and highly adaptive strategy for coping with aridity, not a primitive way of life while Davis (2016) through the Tuaregs challenges environmental determinism by showing how political and colonial histories, rather than just climate, shape a society's vulnerability. By implication, the systems were not simply a direct response to the environment; they were disrupted by historical factors like French colonial borders (Bankoff, 2001), which made these societies more vulnerable to drought. This historical context is often overlooked by simplified environmental determinism, such as that of Diamond (2005), which failed to account for how political history shapes climate vulnerability. Another achievement that highlights the value of traditional ecological knowledge (TEK) and a comprehensive

awareness of the ecosystem, challenging the notion that exploration and settlement can only be accomplished with advanced technology is the Polynesian population of the Pacific Ocean in a sustainable manner achieved through employment of ecological literacy and celestial navigation (Kirch, 2017).

Thirdly, ecosystems are essential to human survival because they supply essential services like clean water and air. Because of their foundation in biodiversity, these healthy ecosystems are more resilient and able to support human life. Indigenous societies understand biodiversity not merely as a resource but as essential to their cultural and spiritual survival, and they frequently have profound ecological knowledge and practices that reflect this interconnectivity. Since biodiversity loss undermines the basis of human well-being and a variety of lifestyles, it directly threatens ecological stability as well as cultural wealth (Toledo, 2013). A great example comes from indigenous technologies. For example, the Amazonian Yanomami view biodiversity as kin, practicing agroforestry that mimics natural ecosystems (Kopenawa & Albert, 2013). Also, the Gonds of India worship sacred groves as abodes of deities, preserving biodiversity while the Kodagu's sacred forests in India sustain endemic species through ritual protection (Bhagwat & Rutte, 2009). Similarly, Māori whakapapa ties humans to ecosystems through genealogical bonds (Salmon, 2017).

Turning attention to Nigeria, the Yoruba people in southwestern Nigeria have a deep spiritual connection to biodiversity, with conservation often rooted in religious beliefs. They protect sacred groves and forests, dedicated to deities, from human exploitation through strict taboos. This traditional conservation strategy preserves *flora* and *fauna*, while also preserving specific animal and plant species as symbols of identity for clans (Adesawe, 2023). Similarly, the Hausa people in northern Nigeria value biodiversity for its medicinal properties, using their traditional medicine system, or Hausa herbology, to create remedies for various ailments. They value plants for their healing and sustenance, contributing to traditional biodiversity management. This understanding of plant ecosystems and sustainable harvesting ensures the continued availability of resources, unlike the Yoruba-style spiritual approach (Adegbite, 2025). Then the Igbo people in South-eastern Nigeria value biodiversity for food security and socio-cultural identity. Their agricultural practices and festivals are deeply connected to yam, a symbol of sustenance and hard work. Igbo traditional food systems also include wild vegetables, fruits, and animals. Knowledge of these sources is passed down through generations, ensuring sustainable collection and use (Okeke et al, 2008; Akindele, 2021).

In contrast, Western conservation models, which often use universal concepts like "biodiversity hotspots," can clash with biocultural diversity

frameworks that link species directly to a community's cultural identity and worldview. This tension suggests that while Western conservation sometimes appropriates indigenous spiritual values, it often fails to respect the land rights and self-determination of the very communities whose knowledge is essential for true conservation (Tuck & Yang, 2012). In other words, modern industrial agriculture prioritises high yields through monocultures and a reduction in biodiversity, which makes ecosystems vulnerable to collapse (Tilman, 2002). This contrasts with traditional and alternative systems that promotes biodiversity and resilience. These examples demonstrate a tension between industrial systems that prioritise endless growth ("treadmill of production") and sustainable, place-based practices. This tension is further complicated by the fact that global assessments often struggle to incorporate localised knowledge, as noted by IPBES (2019). Thus while ecosystem services like pollination and flood regulation are essential for everyone, societies prioritise them differently based on their cultural values. Fourthly, human activity has significantly shaped the planet, leading to the Anthropocene era. This global era demands a coordinated response to global climate and ecosystem changes, considering universal ecological limits and cultural differences (Whyte, 2018). As a result, indigenous ontologies and non-Western ecological practices, like the Islamic *hima* and Jewish *shmita*, offer alternatives to the historical Western

"dominion" narrative that has often justified environmental exploitation. This narrative, exported through European colonialism, created "sacrifice zones" like Nigeria's Ogoniland. In contrast, practices such as the Pacific Northwest's Potlatch demonstrated sustainable resource management. This stark difference in ecological footprints between the Global North and subsistence societies highlights a racialised ecological debt, revealing how capitalist frameworks and fossil capital theory often dismiss or ignore Indigenous knowledge and sustainable practices, such as Ecuador's Pachamama laws, which redefine agency in the Anthropocene (Pulido, 2017; Nixon, 2011).

Thus despite the unified challenge of planetary boundaries, cultural asymmetries lead to divergent solutions, from Western "command-and-control" approaches like geoengineering and de-extinction to de-growth movements and indigenous demands for ethical reciprocity, revealing a need for frameworks that can address these ideological splits in planetary stewardship. This paper posits that Latour's (2017) Gaia theory lacks tools to address such cultural asymmetries in planetary stewardship even though it identified the problem.

Case Studies: Universal Challenges, Local Solutions in the African Context

Africa's diverse ecosystems and cultures provide compelling examples of how universal environmental challenges (water scarcity, food security, and climate change) are met with locally

rooted, culturally informed solutions. Indigenous floodplain agriculture in the Niger Delta (Delta, Rivers, and Bayelsa States) uses the natural cycle of seasonal flooding to grow crops. This practice is sustainable because it utilises the fertile silt and organic matter deposited by the floodwaters, reducing the need for chemical fertilisers (Alade & Bakoji, 2021). For example, Urhobo and Ijaw ethnic groups farmers cultivate crops like vegetables, maize, and yams on the fertile, nutrient-rich soil left behind. Some of them raise fish in the floodplains and use their waste as a natural fertiliser. Similarly, Ogoniland, which includes communities like Oghale rely on the fertile land for crops like pumpkins, maize, and cassava. Further, the Akassa community of Bayelsa aside aquaculture and fishery cultivate crops like sugarcane, pineapple, plantain, yams, cocoyam, sweet potato, etc. Furthermore, communities in arid regions (Kitui and Makueni counties as well as others) build subsurface dams to capture rainwater, recharging groundwater (Lasage *et al.*, 2008). These dams, built across seasonal riverbeds, trap sand and water during rainfall, creating underground reservoirs for domestic use, livestock, and small-scale irrigation. And it needs to be said that these low-tech solutions outperform costly desalination plants in durability and accessibility.

Lagos water crisis offer another case study. Despite investments in piped water, 70% of Lagosians (Nigeria) rely on private vendors due to mismanagement (Ajibade, Mcbean, &

Kerr, 2013). Meanwhile, Makoko's floating community adapts to rising tides with vernacular architecture (Secmen & Ibrahim, 2025). In essence, postcolonial dam projects (e.g., Kainji Dam) disrupted local fisheries while failing to deliver promised irrigation (Ogunjo *et al.*, 2022). This means that Africa's water solutions thrive when blending indigenous knowledge (e.g., Ethiopia's *terracing*) with targeted technology (e.g., solar-powered boreholes). Other indigenous permaculture include Nigeria's *Yoruba Forest Gardens* which mimics natural ecosystems by integrating crops like yam, cocoa, and medicinal plants (Aworinde, 2013). They boast higher biodiversity than monoculture plantations. There is also the Zimbabwe's *Pfumvudza*, a drought-resistant smallholder farming which uses mulch and minimal tillage to double maize yields (Islam, Alam, & Salahin, 2022; Mavesere, & Dzawanda, 2023). These are unlike the industrial monoculture in which colonial plantations replaced diverse agroforestry, causing soil depletion (Udom & Eze 2018). Another case is the Senegal's *Naissé* vs. corporate land grabs in which women's collective gardens preserve millet diversity, while foreign agribusinesses drain aquifers for export crops (GRAIN, 2021).

These case studies indicate responses to climate changes and shows how global policies meets with grassroots resilience. These grassroots resilience yield local adaptation innovations such as the *Mbari* houses where the Igbos use sacred

mud houses for passive cooling, a low-carbon alternative to concrete (Uduku, 2018) and the Sahel's *Great Green Wall*, a localised agroforestry (e.g., *Faidherbia albida* intercropping) which works better than state-led tree planting (Reiji, Tappan & Smale, 2009). Local farmers are utilising these tree leaves for increased crop yields, reversing environmental degradation, and improving food security, thanks to their lack of competition for sunlight and water. In contrast, carbon offset projects have evicted indigenous Baka communities in Congo Basin (Nguiffo, 2018), while Nigeria's gas flaring continues creating health damages and displacements despite COP26 pledges (Oviasuyi, Eweje & Aiyegbusi, 2022). And then in Lagos with regard to its flooding, government seawalls have failed to address the root cause (destruction of mangroves) for elite real estate (Ajibade, Armah & Ajibade, 2023).

Tensions between Universalism and Cultural Relativism

The conflict between cultural relativism and universalism affects global environmental policy. Cultural relativism respects the rights of local groups, whereas universalism, as demonstrated by global accords such as the Paris Climate Accord, advocates for a single, top-down approach. Global initiatives like REDD+ combat climate change but often lead to the eviction of indigenous communities, such as the Baka people in the Congo Basin. These projects disregard traditional land use practices and autonomy, causing climate colonialism. This is what we refer to as

Western conservation models as against traditional ecological knowledge (TEK). This study aligns with "Green Grabbing" that critiques market-based conservation that commodifies ecosystems. Western conservation models often use a "wilderness" concept, removing human influence and restricting activities like controlled burns. This technocratic approach ignores local knowledge, leading to policy misfits and failure to integrate the relational understanding of the locals which have governed the ecosystem for years. In contrast, traditional ecological knowledge (TEK) is a method of conservation based on local cultural practices. Examples include Yoruba, Hausa and, Igbo people in Nigeria, Kodagu forests in India, and Balinese Subak system in Indonesia. These examples show that sustainability is not a universally applicable path, but a patchwork of regional fixes.

This tension centres on whether global sustainability should be pursued through a single, standardised model or through a multitude of diverse, culturally specific approaches. It is in this context that one questions the global seed corporations that promote hybrid maize in Nigeria (AgroNigeria, 2024). Scholars argue that this is a form of agrobiodiversity loss, where a focus on a single, high-yield crop displaces genetically diverse local varieties (Gepts, 2023). In the work of Obiageli's (2020) seminal work "Emancipatory Approach in Entertainment Education for Sustainable Social Change" gives a narration of how a community were

given a new crop to cultivate. Although the crop had high yields eventually, the farmers abandoned it because it did not meet their other needs. Enquiry on the reason for abandonment showed that abundant yield was not the only interest of the framers. Hence the need to incorporate indigenous knowledge. After all, Ethiopia's seed banks preserve 150,000 indigenous varieties (Worede, 2009). These three cases show differing mind-sets. This study argues that there is no one size-fits-all. Drawing from "Monocultures of the Mind" (Shiva, 1993) this study warns against standardizing agro-ecology. Industrialised nations often prioritise a technocratic, growth-oriented model for sustainability. This approach often leads to a homogenisation of practices, where local, diverse solutions are replaced by a one-size-fits-all model.

Obiageli's (2020) is an explication of the danger of not incorporating the community in driving sustainable change. Obiageli intensifies the critique of universalist sustainability models by highlighting participatory communication and community agency in social transformation. The approach posits that sustainable change must originate from within communities via culturally rooted narratives and locally significant modes of communication, rather than through externally enforced technocratic frameworks. In the discourse between universalism and cultural relativism, this viewpoint underscores the frequent inadequacy of development and environmental policies that exclude indigenous voices

and epistemologies. The emancipatory approach emphasises the ability of communities to interpret, negotiate, and promote sustainability practices rooted in their lived experiences by endorsing entertainment-education strategies that integrate social learning within culturally relevant storytelling and media. Obiageli's framework supports the main idea of this study, which is that sustainable environmental governance should not just follow global rules but also include local knowledge systems like Traditional Ecological Knowledge (TEK). This way, communities can be active participants in sustainability efforts instead of just receiving them.

Synthesis and Critical Evaluation of Issues

Our central theoretical intervention is to destabilise the assumed naturalness of the universal-particular divide in environmental thought. We have argued that what is typically presented as a distinction between universal ecological constraints and culturally specific adaptations is, in fact, an epistemically produced boundary embedded in historically situated regimes of scientific authority and global environmental rule-making. Hence ecological "universals" are not simply discovered biophysical realities; instead they are stabilised through measurement infrastructures, institutional protocols, and policy architectures that privilege abstraction as the dominant mode of environmental legibility.

Across the empirical cases (Subak irrigation systems, Sahelian

agroecological practices, Arctic Indigenous knowledge systems, and African floodplain adaptations), the analysis showed that ecological order is not external to society but co-produced through socio-technical and cultural assemblages. What is commonly described as “adaptation” is better understood, in line with political ecology and science and technology studies, as a process of co-production in which nature, knowledge, and governance are mutually constituted through situated practice rather than arranged in hierarchical relation.

This immediately unsettles the paper’s own implicit asymmetry between ecological universality and cultural variability. By positioning ecological principles as fixed boundary conditions and cultural systems as contingent responses, environmental discourse risks reproducing what decolonial theory identifies as epistemic coloniality: the elevation of Western scientific abstraction to the status of global interpretive baseline. Yet this abstracted environmental rationality is itself historically produced, entangled with colonial extraction, capitalist expansion, and contemporary technocratic environmental management regimes that determine what counts as valid environmental truth.

At the same time, the corrective turn toward Indigenous and local ecological knowledge introduces a second-order tension. While it disrupts scientific universalism, it can also slide into epistemic essentialism, where TEK is stabilised as inherently relational,

sustainable, and normatively superior. This move risks converting Indigenous knowledge into a functional resource for environmental problem-solving, thereby obscuring its internal heterogeneity, political contestation, and historical transformation. Neither scientific ecology nor TEK exists outside relations of power; both are situated knowledge formations whose authority is produced through different but comparable regimes of validation and institutional recognition.

The unresolved issue, therefore, is not the reconciliation of universality and particularity but the governance of their productive antagonism. The empirical material demonstrated that sustainability is not achieved through harmonisation but through friction: competing ways of knowing continuously negotiate what counts as ecological reality, whose knowledge becomes actionable, and which life forms are rendered viable under conditions of environmental change.

Crucially, this implied a stronger structural claim. The universal-particular distinction is not merely an analytical inconvenience but a constitutive feature of modern environmental rule. As long as ecological universals are operationalised through technocratic forms of environmental standardisation, and cultural knowledge is confined to localised arenas of practice, sustainability regimes will continue to reproduce the very asymmetries they claim to resolve. The issue is therefore not insufficient integration, but the

political economy of environmental abstraction itself: the systematic privileging of scalable, commensurable forms of knowledge over situated, relational ecological practices.

What follows is not synthesis but an account of systemic constraint. Sustainability, under current conditions of environmental governance, cannot be understood as the harmonisation of knowledge systems. It is instead an agonistic field in which competing ontologies of nature are continuously produced, stabilised, and contested. Environmental crisis, in this framing, is not simply a failure of coordination across scales, but an effect of the very regimes through which ecological reality is rendered intelligible, governable, and administratively actionable.

Conclusion

This paper has argued that the apparent opposition between universal ecological constraints and culturally specific environmental practices is less a natural divide than a historically produced way of organizing environmental knowledge and governance. What presents itself as ecological universality is, in practice, stabilised through institutionalised forms of abstraction, measurement, and policy standardisation, while cultural responses are rendered as situated adaptations within those pre-defined limits. Yet the empirical cases demonstrated that environmental order is never simply imposed by nature or interpreted by culture; it is continuously co-produced through socio-technical arrangements, local knowledge systems,

and political-economic structures that determine how ecological realities become visible and actionable.

In this light, sustainability cannot be reduced to the integration of scientific and Indigenous knowledge into a unified framework. Instead, it emerges as a condition of managed tension between competing ways of knowing, governing, and inhabiting ecological systems. The persistence of environmental crisis reflects not merely gaps in coordination, but the structural consequences of privileging abstract, scalable forms of environmental reasoning over situated, relational ecologies of practice. A more adequate response, therefore, is not synthesis in the sense of resolution, but an institutional and epistemic openness to enduring pluralism—one that recognises sustainability as an ongoing negotiation within irreducible ecological and political asymmetries rather than a final state of agreement.

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