

PERSPECTIVES

ESSAY

Reimagining the human

A human-centric worldview is blinding humanity to the consequences of our actions

By Eileen Crist

Earth is in the throes of a mass extinction event and climate change upheaval, risking a planetary shift into conditions that will be extremely challenging, if not catastrophic, for complex life (1). Although responsibility for the present trajectory is unevenly distributed, the overarching drivers are rapid increases in (i) human population, (ii) consumption of food, water, energy, and materials, and (iii) infrastructural incursions into the natural world. As the “trends of more” on all these fronts continue to swell, the ecological crisis is intensifying (2–4). Given that human expansionism is causing mass extinction of nonhuman life and threatening both ecological and societal stability, why is humanity not steering toward limiting and reversing its expansionism?

The rational response to the present-day ecological emergency would be to pursue actions that will downscale the human factor and contract our presence in the realm of nature. Yet in mainstream institutional arenas, economic, demographic, and infrastructural growth are framed as inevitable, while technological and management solutions to adverse impacts are pursued single-mindedly. Although pursuing such solutions is important, it is also clear that reducing humanity's scale and scope in the ecosphere is the surest approach to arresting the extinction crisis, moderating climate change, decreasing pollution, and providing sorely needed leeway to tackle problems of poverty, food insecurity, and forced migration (5). The question that arises is why the approach of contracting the human enterprise tends to be ignored.

The answer lies in the deeper cause of the ecological crisis: a pervasive worldview that imbues the trends of more with a cachet of inevitability and legitimacy. This worldview esteems the human as a distinguished en-

tity that is superior to all other life forms and is entitled to use them and the places they live. The belief system of superiority and entitlement—or human supremacy—manifests in a range of anthropocentric commonplace assumptions, linguistic constructs, institutional regimes, and everyday actions of individual, group, nation-state, and corporate actors (6). For example, the human is invested with powers of life and death over all other beings and with the prerogative to control and manage all geographical space. The all-encompassing manifestation of the belief system of human supremacy is precisely what constitutes it as a worldview.

This worldview is not necessarily an explicitly articulated narrative. Rather, it forms the tacit postulate from which people source meaning and justification to disregard virtually any limitation of action or way of life in the ecosphere and toward nonhumans. Human supremacy is the underlying big story that normalizes the trends of more, and the consequent displacements and exterminations of nonhumans—as well as of humans who oppose

that worldview (7, 8). In this context, it is crucial to recognize that human supremacy is neither culturally nor individually universal, nor is it derived in any straightforward way from human nature. However, western civilization has elaborated its most forceful, long-standing expression, and through the West's ascendancy the influence of this worldview has spread across the globe (9).

BLIND TO THE WISDOM OF LIMITATIONS

The planetwide sense of entitlement bequeathed by a supremacist worldview blinds the human collective to the wisdom of limitations in several ways, thereby hindering efforts to address the ecological crisis by downscaling the human enterprise and withdrawing it from large portions of land and sea.

First, because the worldview demotes the nonhuman in favor of the human, it blocks the human mind from recognizing the intrinsic existence and value of nonhumans



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and their habitats. Nonhumans are rendered as resources and considered dispensable or killable; it is assumed that natural areas can be taken over and converted at will.

Second, a worldview founded on the elevation of the human impairs the experience of awe for this living planet, inducing instead the perception that viewing the ecosphere as a container of natural resources, raw materials, and goods and services makes sense. If humanity inhabited Earth with a profound sense of awe, news of an impending mass extinction would galvanize the world into action. Instead, what we find is that the response to anthropogenic mass extinction is muted in mainstream media and other social arenas.

Third, based on the conviction of the special distinction of the human, the worldview fosters the belief that humans are resourceful, intelligent, and resilient enough to face any challenges that may come. This tacit missive bolsters societal torpor and

Rising human consumption is driving widespread destruction of natural systems, such as this forest in British Columbia.



political inaction, because it is widely assumed that technological innovations and interventions will overcome problems.

Fourth, the worldview impedes humans from recoiling from, or even seeing, the violence of an expansionism that fuels extinctions, population plunges, mass mortality events, and starvations of nonhumans. Because these experiences are happening to “the merely living,” they are nonissues for mainstream media and the political sphere, which are focused almost exclusively on human affairs. For example, humanity’s impact has become so pervasive that migratory animal species are in decline and the very phenomenon of migration is disappearing around the world. Yet neither the loss of animal migrations nor the suffering of the animals involved seem to be matters of concern in public arenas.

Lastly, the supremacist worldview insinuates that embracing limitations is unbefitting of human distinction. Whether openly

or implicitly, limitations are resisted as oppressive and unworthy of humanity’s stature.

By operating on all these levels, the worldview of human distinction-and-prerogative obstructs the capacity to question human hegemony for the sake of Earth’s inherent splendor and in the service of a high-quality human life within a downsized, equitable global civilization nested in an all-species commonwealth. Instead, the trends of more—on the population, consumption, and infrastructure fronts—are left to persist their course seemingly unassailable.

TOWARD SCALING DOWN AND PULLING BACK

The reigning human-nature hierarchical worldview thus hinders the recognition that scaling down and pulling back is the most farsighted path forward. Scaling down involves reducing the overall amount of food, water, energy, and materials that humanity consumes and making certain shifts in what

food, energy, and materials are used. This quantitative and qualitative change can be achieved by actions that can lower the global population within a human-rights framework, shrink animal agriculture, phase out fossil fuels, and transform an extractionist, overproducing, throwaway, and polluting economy into a recycling, less busy, thrifty, more ecologically benign economy (10–12). These shifts must align with a new ethos in civil society toward shared norms of mindfulness around dietary choices, avoidance of waste, conservation of energy, and reuse and recycling of materials.

Scaling down can be complemented with substantially pulling back our presence from the natural world. Achieving continental-scale protection of terrestrial and marine habitats will enable sharing Earth generously with all its life forms (13). Recent research reveals that large-scale nature conservation is also a powerful counter to climate change by absorbing a sizable portion of the carbon dioxide of the industrial age and preventing additional carbon (stored in the ecosphere) from being released (14, 15). Vastly expanding marine protected areas will support the resurgence of marine life. Ambitious forest, grasslands, freshwater ecologies, and wetlands protection and restoration will prevent extinctions and preempt an anthropogenic mass extinction event. A robust global network of green and blue protected areas will save wildlife populations and animal migrations from their current downward spirals. Preserving the night sky in extensive swathes of wild nature will keep an open portal into the cosmos we inhabit.

Many of the global approaches called for in this pivotal moment may lack the glamour of technological and engineering breakthroughs, but they promise far-reaching strides in resolving the ecological crisis and preventing human and nonhuman suffering. Paramount examples include state-of-the-art family planning services for all (including modern contraceptive technologies), universal education from the age of 4 to 17 or 18, substantial reduction of animal-product consumption, adoption of the reduce-reuse-recycle paradigm as an everyday norm, massive protection of wild nature, and adoption of sustainable and ethical food production practices on land and sea.

BEYOND HUMAN DOMINANCE

The dominant framework of technofixes, technological schemes, and fine-tuning efficiencies is by itself no match for the tidal wave of human expansionism expected in this century. Looming before us is the imminent escalation of food, energy, materials, and commodities production, and resulting increases in wildlands destruction, species

extinctions, wildlife extirpations, freshwater appropriation, ocean degradation, extractionist operations, and the production of industrial, pesticide, nitrogen, manure, plastic, and other waste—all unfolding amid climate-change ordeals.

In the face of this juggernaut, a singular focus on a techno-managerial portfolio seems fueled by a source other than pragmatism alone. That portfolio—which would include such initiatives as climate geoengineering, desalination, de-extinction, and off-planet colonization—is in keeping with the social rubric of human distinction. The prevalent corpus resonates with a Promethean impulse to sustain human hegemony while avoiding the most expeditious approach to the ecological predicament—contracting humanity's scale and scope by means that will simultaneously strengthen human rights, facilitate the abolition of poverty, elevate our quality of life, counter the dangers of climate change, and preserve Earth's magnificent biodiversity.

To pursue scaling down and pulling back the human factor requires us to reimagine the human in a register that no longer identifies human greatness with dominance within the ecosphere and domination over nonhumans. The present historical time invites opening our imagination toward a new vision of humanity no longer obstructed by the worldview of human supremacy. Learning to inhabit Earth with care, grace, and proper measure promises material and spiritual abundance for all. ■

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3D PRINTING

Printing nanomaterials in shrinking gels

Photopatterning of reactive sites in gels enables arbitrary patterning of nanoparticles

By Timothy E. Long and Christopher B. Williams

The creation of nanoscale electronics, photonics, plasmonics, and mechanically robust metamaterials will benefit from nanofabrication processes that allow a designer full control in manipulating nanomaterial precursors in a programmable and volumetric manner. Despite decades of research, it remains challenging to design nanofabrication processes that can produce complex free-form three-dimensional (3D) objects at the scale of tens of nanometers. On page 1281 of this issue, Oran *et al.* (1) report on the photopatterning of reactive sites into water-swollen, chemically cross-linked acrylic gels for the subsequent site-specific deposition of nanomaterials and nanoparticles. After chemical and thermal dehydration, the gel scaffold holds the nanomaterials in a distinct 3D arrangement. This process, termed implosion fabrication (ImpFab) because the scaffold of the gel effectively “implodes” upon solvent removal, provides an opportunity to fabricate centimeter-scale assemblies of nanomaterials that possess multiple functionalities.

The macroscopic dimension of a solvent-swollen gel provides sufficient molecular mobility to host efficient chemical reactions. However, the utility of a covalently cross-linked gel as a “nanomanufacturing reactor” for the creation of programmable nanomaterials has remained unrealized until now. Top-down processes such as photolithography can create structures with spatial resolutions approaching tens of nanometers (2), but the fundamental process methodologies limit the creation of arbitrary geometries in three dimensions.

Researchers are now implementing bottom-up nanofabrication processes that are similar to more recent efforts in additive

manufacturing (often termed 3D printing), in that they can pattern materials in 3D space without a photomask (3). One such process, direct laser writing, is an exceptional process for the preparation of arbitrary 3D geometries (4, 5). Rastering femtosecond laser pulses through microscope optics into a photopolymer precursor enables selective photocuring anywhere in the material through the interaction of multiple photons to create discrete, polymerized voxels (3D pixels).

Although this technique creates 3D structures of any arbitrary geometry, its fabrication resolution is often limited by the wavelength of ultraviolet light to hundreds of nanometers (6, 7). Expanding the material selection for the process beyond electrical insulators has also proven challenging. Cre-

ating functional metallic materials with this process is only permitted through patterning polymer-particle nanocomposites (8), metal-coating the entirety of the printed surface, or multiphoton-induced reduction of metal ions. Postprocess coating does not allow for selective deposition and

limits the geometries that are achievable (see the figure, right). Irradiating polymer composites and multiphoton-induced reduction of metal ions constrain resolution through refraction effects and the limited control of growth and aggregation during photoreduction, respectively (9).

As such, fabricating truly arbitrary 3D metallic shapes at the scale of tens of nanometers has yet to be demonstrated. Researchers remain challenged to circumvent the resolution and material selection constraints imposed by direct laser writing. Oran *et al.* combined the unusual volumetric reduction properties of water-swollen gels (hydrogels) and a templating approach to fabricate complex 3D metallic nanostructures at an unprecedented scale (see the figure, left). They leveraged the stable deswelling performance of a hydrogel in the context of metallic nanofabrication. In particular, they photopatterned water-swollen gels with two-photon laser direct writing to

“..Oran *et al.* avoid any detrimental interactions of nanoparticles during exposure...”

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