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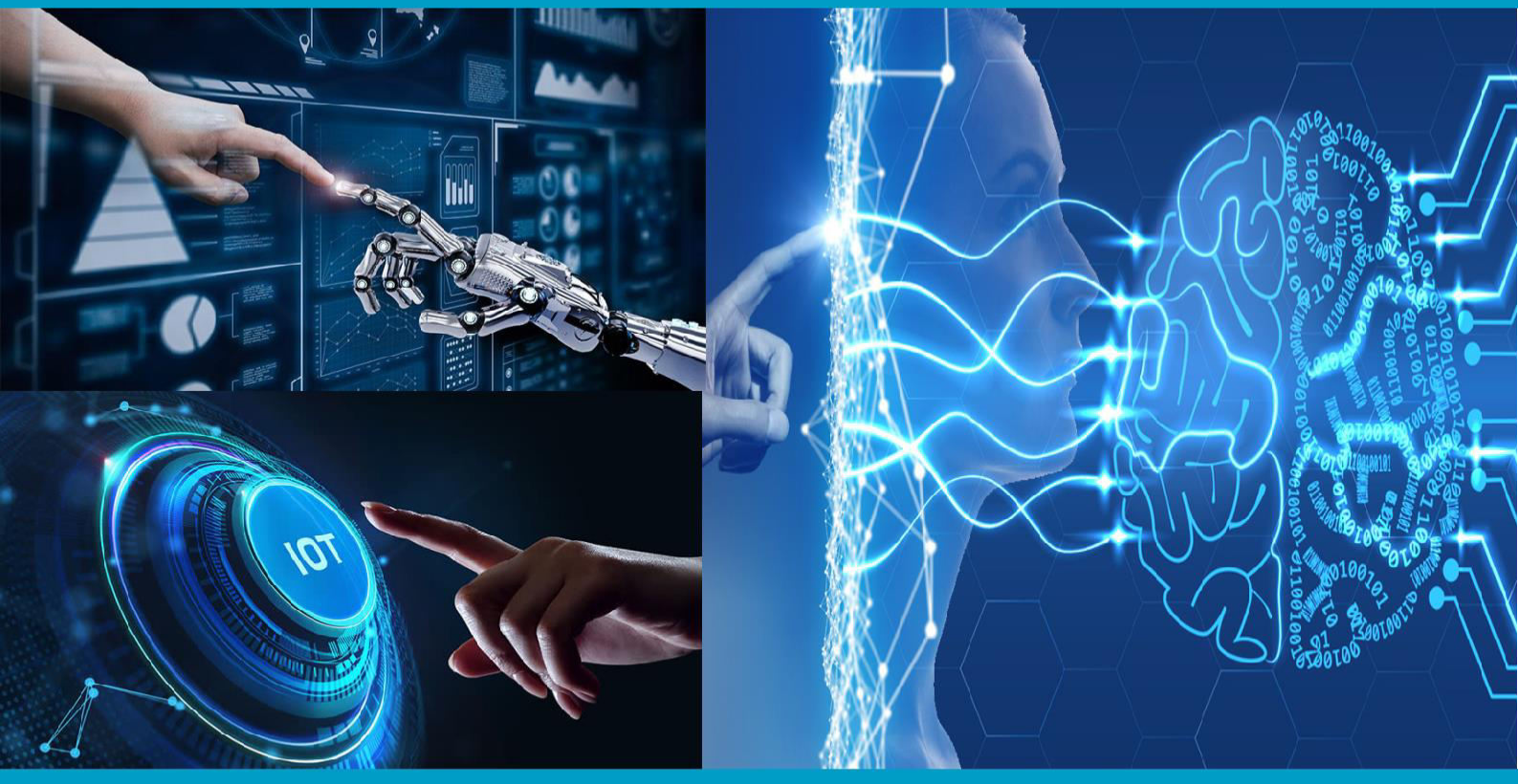

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Narratives of Change: Environmental Humanities and the Literature of Climate Crisis

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ABSTRACT: Recently, the environmental humanities have become a recognised area of study, encompassing environmental orientations within the humanities. It is noted that, generally speaking, the humanities engage in a critical and reflective stance regarding ways of understanding the world, while the environmental humanities do so in relation to environmental matters. Four key themes, describing the environmental humanities, namely, values and justice, narratives, temporalities, and the culture of nature, are identified. These themes subsequently are further explored by reflecting on the relation of climate change to various types of injustices, the role of catastrophist narratives, the importance of temporal dimensions, and the interaction of cultural conceptions of nature and human capacities to address this phenomenon. It is concluded that the approaches of the environmental humanities may be useful to reflect on how one may live with climate change.

KEYWORDS: environmental, humanities, literature, climate, crisis, narratives

I. INTRODCTION

As greenhouse-gas emissions increase, as carbon sinks are further degraded or destroyed, and as average global temperatures continue to rise, the impacts of climate change increasingly touch every aspect of planetary function and human life, from what and how much we eat, to where we live and how we die, to our basic economic, political and societal stability. We have entered a new reality, which scholars across disciplines now call [1,2,3]"the Anthropocene," a geological epoch in which the human species has acquired a power equal to that of the Earth's bio- and geophysical systems. Consider, for example, how humanity has damaged the planet's soil (roughly half the earth's topsoil has been lost in the past 50 years), heated the atmosphere past tipping points (scientists say the melting polar ice caps are now irreversible), acidified the oceans (some ecologists predict saltwater fish will be gone by 2048), and ushered in the greatest mass extinction since dinosaurs were wiped out (the planet is losing species at between 1,000 to 10,000 times the normal background rate) (Arsenault; Notz; Worm; Barnosky). Consider too how small invisible changes—such as parts-per-million increases in particular atmospheric gases—can upset the flow of heat energy into and out of the global atmosphere and thus alter long taken-for-granted climatological and biophysical systems everywhere on the planet. The consequences of such irreversible changes can be overwhelming and often frightening. Cascading shifts in ecological systems cause unpredictable social impacts, particularly in the context of food production, water availability, emergency relief, infrastructure integrity, economic stability, and international relations. Climate change is what policy analysts and scholars refer to as "a threat multiplier," exacerbating existing conflicts and increasing global political instability, and the Pentagon and top military officials warn that climate change is the greatest threat to U.S. national security in the twenty-first century (Campbell et. al). To echo the environmental writer Naomi Klein, the seemingly simple fact that CO2 and other greenhouse gases pause for varying lengths of time in both the lower and upper atmosphere, changes everything. And despite the trumpeting of techno-optimists or proponents of grand geoengineering schemes, neither can we return to a preanthropogenic-climate-changed world nor can we rely on technology alone to create a "good" Anthropocene.1 However, although impacts are proliferating both near and far, it remains difficult to acknowledge the extent to which climate change is imbricated into every aspect of our lives. There are many reasons why individuals have been slow to recognize these interconnected realities. For one, climate change is often perceived as a set of complex and intangible phenomena, representable only through difficult-to-decipher datasets or graphs. Climate change is also assumed to be a distant problem, with impacts experienced only elsewhere and in the future, and its enormity is beyond easy comprehension. According to Timothy Morton, climate change is a "hyperobject," a phenomenon that involves profoundly different temporalities and spatial scales than those we are used to on a day-to-day basis. As a hyperobject, climate change is something that cannot be realized in any specific instance and so is simply too big to see (Morton, Hyperobjects 2). Many scholars have similarly pointed out that humans simply aren't evolved to be able to comprehend and respond to a threat like climate change. Environmental philosopher Dale Jamieson notes that "evolution built us to respond to rapid movements of middle-sized objects, not to the slow buildup of insensible gases in the atmosphere" (4). It's easy to be concerned about a snake that has suddenly slithered its way into your living room. It's harder to be concerned about something that's mostly undetectable by the naked eye, a threat that's gradual, invisible, and diffuse. Further compounding the conceptual difficulties posed by climate change are the

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| Volume 11, Issue 5, May 2024 |

difficulties posed by its ideological baggage. Given the long history of energy companies and far-right think tanks spreading doubt and misinformation, climate change has become a highly partisan issue, particularly in the U.S., with the contentious "debate" being largely a function of conflicts in individual ideology (Bliuc et al. 226; Hulme 18-28). 2 For a majority of people, then, climate change is an abstract, impersonal, and ideologically-charged issue and thus not a topic to be brought up in regular conversation. A 2015 study conducted by the Yale Project on Climate Change Communication reported that only four percent of Americans hear a friend or relative talk about climate change at least once a week (Leiserowitz 10).3 Just four percent. Environmental writer and activist George Marshall identifies[2,3,4] the dearth of climate change conversations as part of a pervasive "meta-silence" about the issue ("meta" because it is so silent, people can't even talk about not talking about it): "The most influential climate narrative of all may be the non-narrative of collective silence" (Marshall, Don't Even Think 82). Bruno Latour similarly calls this culture of silent denial "climato-quietism" and recognizes it as one of the most fundamental barriers to building a more just and sustainable world ("War and Peace" 54). In this context the cliché is correct: The first step to addressing a problem is recognizing that there is one. The second step is talking about it. Given that climate change is an abstract, complex, multi-scalar, multi-temporal, and ideologically divisive issue that resists integration into everyday conversation, one might assume that what's needed is to better inform the public: that is, more climate change information more of the time. This "information deficit" approach holds that people are uneducated and so need more information in order to care more about the issue and subsequently to take action. It is an appealing conceptual framework, one in which the public is unknowledgeable and uncaring and activists and communicators must diligently fill in this knowledge-care gap. However, a range of scholars, including environmental communication researchers such as Susanne Moser, Lisa Dilling, and Harriet Bulkeley have questioned this model, challenging the claim that the apparent gap between caring and actions arises from a lack of knowledge or understanding. By contrast, as these and other researchers have demonstrated, simply communicating the facts of climate change in more convincing or compelling ways does not lead to greater public engagement, more support for climate change policy, or a stronger commitment to taking individual action. More information does not lead people to think, feel, or act more regularly in response to climate change. And in fact, the assumptions behind this claim might themselves be flawed. As Kari Norgaard's important sociological and anthropological work has shown, many people already do think, and feel, regularly about climate change. Counter to the dominant narrative that people simply don't care, more and more people are in fact already grappling with the personal and emotional dimensions of climate change, even if they are not taking action. To put it more succinctly, the care's already there. But when people confront the realities of climate change, they often experience difficult emotions such as guilt, shame, sadness, anger, and anxiety. As psychologist Rosemary Randall explains, "climate change is a disturbing subject that casts a shadow across ordinary life," but who would want to discuss, let alone acknowledge, such a shadow? That is, feelings about climate change often function as their own[3,4,5] barrier to action. In her research and writing on climate denial in Norway and the U.S., Norgaard offers a more complicated and nuanced view of the relationship between people's feelings about climate change, their identities, and their positions in social structures and communities. Questioning the commonly held assumption that climate change is an impersonal issue, Norgaard suggests that one of the challenges to fostering greater public engagement and personal commitment is precisely that climate change is so emotional, so freighted with caring.

II. DISCUSSION

Increasingly, researchers share climate information as narratives to support decision-making and public action. In these contexts, however, scientists remain the focal storytellers. This article offers our methodology for researchers and communities to share narratives with each other and then to engage in collaborative storytelling. At the center of this work is how the humanities embrace the importance of narratives having gaps—narrative lacunae into which individuals can insert their experiences, needs, and values. Our storytelling- and gaps-based methodology allows communities and researchers to enter and transform each other's stories. We offer a simulation model that fosters collaborative storytelling and give examples from the storytelling and social-environmental action projects that have emerged over three years of partnership with communities and university students.

The massive scale and inherent uncertainty of climate change often drive a wedge between researchers and the public—a divide widened by the differing languages and epistemologies that separate researchers from the broader community.1 To help bridge this divide, scientists have become interested in storytelling to connect research findings with lived experience. They often ask, How can we tell a better story? Be better storytellers?2 They thus make research relevant and accessible by crafting narratives with engaging plots and relatable characters, often including part of their own personal story. But scientists remain the ones who produce and control those narratives. Humanities scholars, conversely, emphasize that the broader public needs to engage in the narrative-making themselves. As Raul P. Lejano, Joana Tavares-Reager, and Fikret Berkes have noted, "Issues like climate change need to be integrated into the everyday [4,5,6]narratives that people tell about themselves and their world."3 How might the narratives of climate research become integrated into people's personal narratives? And how might these narratives enter and transform

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| Volume 11, Issue 5, May 2024 |

those of researchers—in keeping with the upsurge of interest in researchers and communities coproducing knowledge?4

In our collaboration as a Shakespeare professor–turned-public-humanist, a hydrologist working on social-environmental simulation, and a climate scientist and Lead Author for the Intergovernmental Panel on Climate Change's Assessment Reports, we have developed a methodology for researchers and community members to first tell narratives to each other and then go further to engage in storytelling together.5 We distinguish between narrative (the personal experiences individuals recount to each other) and storytelling (a broader communal process embracing diverse ways of knowing and involving reciprocal connectedness). Narrative is a singular expression; storytelling is a shared act, often likened to weaving, often associated with kinship. Such storytelling has millennia-deep roots in Indigenous cultures and occurs in such collaborative performance contexts as Climate Change Theatre Action, the Theatre of the Oppressed, and the "cognitive ecology" of the shareholder-actor companies of William Shakespeare's early modern theater.6 Paradigms of collaborative storytelling are polyvocal and, as such, expand the imaginations and capacities of those involved. It was to pursue these goals with communities as our partner-storytellers that our transdisciplinary collaboration began.

Our storytelling methodology joins disciplinary practices from climate science, the environmental humanities, participatory human-natural systems modeling, performance studies, and the relationships-to-resilience ties of social capital from the social sciences.7 These practices contribute different strands to the process. We draw on climate science's work on storylines for memorable events and the scenario capabilities of computer simulation modeling that can convey interdependencies across human and natural systems. Fostering climate action, however, requires more than just the description of human-natural connections: it requires direct relationship building. For this we incorporate social capital building, with its emphasis on collaborative ties for resilience across diversity—a focus that we strengthen through community-empowerment work from performance studies. Also and most profoundly, the environmental humanities expand the human ties of social capital to kinships across the human and more-than-human realms (including Indigenous cosmologies) and elevate narratives of the silenced and the marginalized.

At the center of this cluster of disciplinary practices is the need for communities and researchers to engage in storytelling as a shared act. To address this element, we employ one principle: humanities can help us "mind the gaps"—in literary narratives based on research in cognitive narratology and in the narratives of climate change research itself. In both types of minding the gaps, storytellers cede control of a narrative and allow others to enter as partners. Gaps could be considered[5,6,7] simply unfilled spaces or places of disruption, but the humanities approach gaps as places of opportunity and attention. In cognitive narratology, gaps are spaces where details, connections, and contexts remain unspecified or unresolved—spaces readers fill with their own experience and needs and thus become collaborators with the author.8 For example, in Romeo and Juliet, William Shakespeare leaves unspecified the reason the lovers' families are feuding—a gap that allows each production and reader to place the conflict within issues currently polarizing a community. Likewise, in Sila, Chantal Bilodeau allows each production to decide how to embody the more-than-human world, such as how Mama and Daughter are portrayed and the representation of Nuliajuk's hair.9 Bilodeau and Shakespeare know the power of leaving space for others to enter the narrative and layer in their own contexts and questions. This approach has synergy with Mike Hulme's work on the gaps in climate change knowledge. He emphasizes that the scientific community treats these gaps as spaces of absence that should be filled with "firmer facts," whereas the humanities allow gaps to be places of weakness that require thickening knowledge through public conversation and value-laden exchange. Gaps are places of brittleness that should be minded—paid attention to, heeded.10

Our work combines these two humanities-based approaches to gaps, approaching them as sites where researchers resist filling the space with their own narratives of knowledge and as sites where researchers invite others into collaborative storytelling. To facilitate this process, we use a storytelling tool—our simulation model, called "Community Environment" (CE). It supports groups in moving from individual narrative-sharing to collaborative storytelling through its gaps—aspects, details, and inadequacies that require researchers and community members to fill in together.11 CE uses an agent-based modeling approach that simulates interactions between autonomous entities ("agents") in a system. Like every other simulation model, CE cannot represent all possible interactions and agents and thus is inherently full of gaps. CE's gaps are places of brittleness that can be strengthened by layering diverse knowledges around these gaps to form a bridging web. This essay offers our paradigm of using gaps to foster collaborative storytelling; the process of using CE to move from "narratives-to" to "storytelling-with";[6,7,8] and excerpts from the storytelling, reflections, and action projects that have emerged in our collaborations with communities and students.

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| Volume 11, Issue 5, May 2024 |

Narratives to Collaborative Storytelling to Action: The Overall Trajectory

In our methodology community groups and students share their narratives first. Only after they share and discuss their personal and local narratives does the process begin to include the CE model. CE fosters narrative-making through a design that, as one student described it, "asks as much as it answers."12 CE's gaps allow personal and research narratives to enter each other, expand into storytelling among collaborating experts, and then support action. Our fellow collaborators include women farmland owners, facilitators of the Women Caring for Land program (through the Women, Food and Agriculture Network [WFAN]), a neighborhood group, a city-water-programming coordinator, local conservation board naturalists, a K–12 teacher, and university students. How our team first connects with these groups happens in various ways—from a stakeholder hearing about our process at a conference and wanting to include it in their programming (WFAN, the women landowners, and the K–12 teacher) to our team's outreach (water-programming coordinator and neighborhood group) to our university students, who recognize that collaborative and community-connected work is in their future.

Typically the storytelling sessions take at least two hours (which can be divided into two shorter sessions), but having multiple sessions within a larger program (e.g., sessions with women landowners) allows the collaboration to develop more fully. Discussion at the session's end fosters applying these ideas to action. Our research team provides some funding for community groups to put their climate-wise projects into action. Each group's collaborative storytelling yielded different action. Women farmland landowners and neighborhood groups increased conservation practices (cover crops, no-till farming, native prairie plantings), undertook sustainable urban conservation practices (tree and native prairie plantings, composting), and sparked community building with interest in diversity, equity, and sustainability. We have also coauthored a journal article—with the women landowners as full coauthors—to elevate the wisdom of these women who are among the most potentially powerful yet silenced populations in agriculture's patriarchal system.13 With the K–12 teacher we created a CE- and storytelling-based curriculum for middle schoolers that allows them to discover interdependencies and their own expertise. With university students we explored transdisciplinary paradigms of collaboration to address entrenched challenges—often called "wicked problems"—and considered modes of inquiry the literary humanities bring to transdisciplinary and community-empowering work.

Telling Narratives to Each Other with Communities Controlling the Process

At the beginning of a storytelling session, each individual shares a memory/scene from [7,8,9]their life that is important to their story of land, weather, water—conveying who they are, what matters to them, what they are thinking about in their decision-making. Researchers listen. We, as researchers, do not come with precreated stories assumed to be relevant. Thus when it comes time for researchers to share their narratives, what gets shared is determined by what narratives community individuals share and then create together with CE. Climate change is integrated into situations that individuals will have experienced in some way. This notion of climate narratives and lived reality is deeply influenced by an emerging approach to climate narrative-making called storylines. With storylines scientists share multiple possible climate futures by likening those conditions (and their impacts) to events that stakeholders would recognize or might have experienced. More frequent periods of intense rainfall may be likened to Hurricane Ida, which caused considerable loss of life and damage, not only along the Gulf Coast but also hundreds of miles away, in the northeastern United States. Extended periods of extreme heat could be likened to the 2003 heat wave in France, which decimated crops and caused over fourteen thousand deaths.14 Our storylines process embraces this stakeholder-focused methodology, particularly with Regina Rodrigues and Theodore Shepherd's bottom-up approach, and then adds one additional strategy: community users devise multiple scenarios themselves.15

This notion of agency and action with tangible effects is a foundational principle in that community members and students run CE and in the computer methodology—agent-based modeling (ABM)—used to create it. Agent-based models (ABMs) simulate individual, observable "agents" who respond to each other and surrounding conditions with microdecisions that, when enacted repeatedly, can create substantial and sometimes surprising changes to the larger system.16 With CE the larger system spans the human and more-than-human realms, allowing multiple entry points of interest into the narrative-making. CE is built using principles from geophysical and social science research (climate projections, hydrology, land-use practices, the human ties of social capital, biodiversity) that have tangible, observable causation (rainfall, dry spells, erosion, water degradation, species loss/thriving, human environmental action projects or lack of them). CE's agents are rain, people, select species crucial for ecosystem health (butterflies representing pollinators; mayflies and dragonflies representing often-overlooked species with varying tolerances to pollution), and different types of land (from resilient land with deep-rooted [8,9,10] vegetation/year-round roots in the ground to the hard surfaces, such as pavement or compacted soil, that allow damaging runoff).

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| Volume 11, Issue 5, May 2024 |

These agents interact in narrative arcs that play out based on principles emerging in research for what is needed for climate adaptation and resilience—not just knowledge of geophysical conditions but also the interconnectedness of human and more-than-human realms. The diversity of agents and causations in these narratives allows individuals to enter the process based on their different interests and expertise. This point is crucial. We have found that many individuals who believe they lack the knowledge to take climate-wise action discover that their own gifts in community building are just as important. Suddenly the narratives of climate resilience have places where they fit.

Community groups and students have agentic control over what elements matter most to them when they decide different scenarios with CE. Using the controls on the left side of the interface (fig. 1), they adjust the top three controls to set the climate, which ranges from dry to wet and can involve turning on or off the more extreme conditions of dry spells and downpours that climate projections indicate will intensify and compound. They also adjust two settings on the bottom left to establish the number of humans ready to take action and the degree of community collaboration. True to anthropogenic climate change, only human agents have the responsibility to take the action needed to make the community environment resilient.

How far each human agent can travel and enact change is based on the amount and diversity of the community's collaborative ties—what social scientists call social capital. Social capital involves the range of relationships that foster cooperation, trust, and collaborative action—from the bonding ties of close-knit, like-minded people to the bridging ties that emerge when people from various groups and backgrounds work together. Bridging ties are particularly crucial for resilience; these relationships involve multiple perspectives and allow the fullest range of community members to share and access information and resources.17 Based on CE's settings, the narrative arc of these interactions unfolds in both the visual field in the middle and the graphs to the right (fig. 1). Each narrative arc takes less than five minutes to run (facilitating multiple explorations) and depicts a timespan of about ten years to support smaller-scale action projects with shorter planning horizons.

That is the extent of agents and basic narratives that CE can portray: CE is cartoonishly simple. Its simplicity makes it profoundly inadequate for capturing the complexities of anthropogenically caused climate change. But that is the point. CE's sparsity is gap-driven. As with a microfiction, its ample gaps open up infinite and endless possibilities. As one neighborhood group user commented, "I bet this model does something different for each group. I find that liberating."18

What allows these infinite, unique outcomes are the three types of narrative gaps built into CE's design and the activities that go with it: gaps of nonspecificity, multiplicity, and revision. Gaps of nonspecificity invite researchers and community members to share their narratives and enter the conversation as equally needed experts. Gaps of multiplicity foster exploration of multiple and competing ideas in what could be brittle places in climate change uncertainty and disagreement—but in a low-stakes context where individuals might find a common place to layer knowledges together. Such gaps build agency through diversity and foster collaborative storytelling across different ontologies. Finally, gaps of revision evoke and invite counter-stories that draw attention to the blind spots in the original research narratives and then use these places of brittleness as opportunities to envision new possibilities that communities and researchers create together as fully collaborating experts.

Engaging in Storytelling with Each Other by Minding the Gaps

Gaps of Nonspecificity

Gaps of nonspecificity in CE involve elements left purposefully undefined. For example, in the setting for "individual readiness," there is no specificity about what constitutes readiness. The visual landscape is highly abstract; the geographical location is not predetermined. These gaps prompt groups to consider value-laden questions: What is useful or needed for us and others we know to be ready to take action? What location matters to us—a farm, neighborhood, watershed, entire region? Cognitive narratologist H. Porter Abbott describes how such permanent gaps create a place for questions that the existing narrative does not answer.19 Gaps of nonspecificity stimulate the human brain's natural creativity to fill in what is missing with knowledge from experience and memory in an act that Yanna Popova and Elena Cuffari call "participatory sense-making."20 It is the first step of inviting personal narratives to connect with research narratives.

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| Volume 11, Issue 5, May 2024 |

This type of gap-filling occurred in an individual storytelling session with a woman landowner, Tess. One scenario she chose drew her to two "not ready" pixel people who, over the course of the run, became "now ready" to take action (fig. 2). Noticing these two figures, she filled the gap of what is needed for readiness in her own story:

I'm just going to interject with something here that I've kept to kind of keep me going. There is in a different field that I had done a bigger project, and one of the neighbors said this to me. He had brought his mom back out to the farm to show her a few things and talk about a few things that were going on. So they have to drive by my place, and she said, "Oh, what's [Tess] doing," and he told me that he told her: "What the rest of us need to do: you take on a project each year to help improve the farm." . . . It is also nice to not feel like you're the only one doing things or that has a mindset like this.21

CE's narrative gap of nonspecificity about what constitutes readiness evoked Tess's personal story about what has supported her own readiness to take action.

Tess's story about readiness through relationships became part of the cluster of micronarratives she shared that involved how she had taken incremental action, step by step—just as smaller projects create larger outcomes in CE. Mapping this discussion of social-environmental connection to her next climate-wise steps, she worked with a tenant who had not wanted to try cover crops. She collaborated with him and used project funding to buy cover crop seed for a many-acre field of her highly erodible land. Her approach of partnership and support was so successful that the next season he[9,10] implemented cover crops voluntarily. CE's simplicity provided the openness to invite Tess's story about achieving readiness through collaboration. The narratives of social-environmental connectedness from the research brought out and joined aspects of her lived reality. Such integration of land stewardship and relationships has long been recognized in Indigenous cultures, as Robin Wall Kimmerer has famously noted: "It is relationship that will endure and relationship that will sustain the restored land."22

As groups fill in the gaps of nonspecificity, their storytelling often reveals how each of them brings a different and needed piece that can foster collaborative action. The neighborhood group we worked with was interested in conducting a waterwise project on land surrounding their condominium building. At a storytelling session, the group comprised individuals (most of them retired) living in that building, their city's stormwater manager, three researchers, and an international graduate student involved with climate action at the nearby university. Their discussions about CE regarding readiness and collaborative ties indicated that the condominium owners were interested in doing sustainability projects and building relationships, particularly with the city and university students—our motivation for bringing these diverse individuals together for the session.

By filling in the narrative of what readiness meant, the owners determined that the manual labor needed for the projects was an impediment to their readiness. In turn, the international graduate student said he and his colleagues wanted to do something on the land locally but had no connection that gave them agency. Their narratives entered each other as they began collaborative storytelling, and they realized that each had aspects of readiness the others needed. As a result of these synergies, the condominium owners, this international graduate student, and a growing group of students he introduced to the partnership now work together on sustainability projects—they have planted trees and native prairie plants and started composting projects.

Equally important, through these relationships they now occasionally cook for each other, do yoga, and garden together as they strengthen their ties across diversity (bridging social capital): "We are this really unlikely, motley crew—Boomers, Gen X, Y, Z; different genders, different ethnicities, different ages. And it all works!"23 Such building of ties is crucial for supporting climate resilience, as social scientists emphasize, and, indeed, another group member notes this very outcome:

For me I had no idea that this would spread beyond my living community, and it has. It has brought in a whole new group of friends: people who have interests in common, people that I would have never had an opportunity to meet and be a part of their lives. I believe in the legacy idea—look . . . that is a tree I planted. But what [this project and its relationships have] given me is pleasure in the present, and that is important to me, especially in the present time [COVID]. It's been a part of my resilience. . . . All of this is a result of a series of encounters and academic exercises that were brought to us that gave us great discipline and gave us purpose. Researchers were also part of this community. Very important.24

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Working with CE, these individuals formed supportive relationships with each other. They also formed supportive relationships with us as researchers that led to action and, in turn, encouraged yet more collaborative connections. Crucially, the openness of the gaps of nonspecificity allowed unanticipated synergies to emerge through storytelling together as contributors with diverse gifts. Everyone learned a great deal from each other.

Another gap of nonspecificity—that of geographical location—had important outcomes for the university students in our STEM and humanities classes who had grown up in widely different locations. CE's nonspecificity of location allowed them to explore the common characteristics and impacts of weather extremes they have experienced in their different communities. They shared their stories of droughts and flash flooding from rural and urban communities in Iowa, North Carolina, Minnesota, California, Texas, Washington, and even Scotland, India, and Siberia. Prompted by the model, one group of just five students shared experiences that ranged from growing up in the extremes of Siberia, to experiencing fluctuations between downpours and drought in Texas, to a recent severe storm in Iowa that was common to the entire group. These conversations highlighted how a range of communities experience impacts of climate change and helped students see that, even if the actual weather events were different, the characteristics of extremes and fluctuations that underlie those different events had commonalities. Because of its visually abstract interface, CE's gaps of nonspecificity allowed personal and local contexts to remain unique to each individual while exploring common elements in their experiences.

This principle of diversity also translates to groups' recognition that their experiences could rest side by side as different manifestations and expertise that benefited from diversity. One student group member said that over time "it dawned on me that our stories all revolved around a connection with the earth and yet were all different. . . . As we went on to doing the simulation, it was entertaining to see how we all lead with different mindsets; some analytical, some creative, some focused on what story there was to tell, others focused explicitly on the data [the graphs]. . . . Ultimately it was a perfect balance."25 A student from a different group also commented on the strengths of the diverse perspectives in his group:

Another thing I noticed was that I would mention more abstract concepts as potential reasons such as religious or cultural details about the community involved. Many of my group members had other ideas about the situation, ones that personally I would not have considered. This also demonstrates the importance of collaboration in storytelling. Maybe it has to do with people's backgrounds or their upbringings, but nobody thinks or processes information the same allowing for differing viewpoints. . . . The differing perspectives others can bring is invaluable, especially in a storytelling or story creation process where having a dominating viewpoint limits a story's potential.26

The multiple perspectives evoked by CE, through its gaps of nonspecificity and ease of use, opened new perspectives and new within-group connections. And, significantly, collaborative storytelling fostered respect across differences. This focus on multiplicity emerges even more emphatically in the next step of the process.

Gaps of Multiplicity

Individuals and groups working with CE create gaps of multiplicity because they are typically asked to devise and run at least six different scenarios that need not develop a coherent trajectory. Such incommensurability through gaps boosts cognition and creativity, as Lars Bernaerts and colleagues note, for gaps in a narrative "not only require an additional effort of the reader but also enable him or her to see something else and to make new narrative connections."27 Gaps foster cognitive expansion, allowing initial aspects of the familiar to stretch and become discoveries that embrace the new. In the storytelling sessions individuals expanded the geographical scale of their thinking (e.g., local plot of land to regional watershed) or expanded their thinking about how human and more-than-human relationship building is all part of climate resilience work. These elements are crucial for collaborative storytelling regarding climate change in particular. The gaps[10] of multiplicity allow discovery to occur at a pace and scale that meet individuals and communities where they are, preventing too large a gap between the scale and uncertainties of the climate crisis and individuals' agency. Bruno Latour addresses how such misalignment can lead to overwhelm: "One of the reasons why we feel so powerless when asked to be concerned by ecological crisis, the reason why I, to begin with, feel so powerless, is because of the total disconnect between the range, nature, and scale of the phenomena and the set of emotions, habits of thoughts, and feelings that would be necessary to handle those crises."28 CE's gaps of multiplicity allow for expansion of scenarios and scales to happen through the interactive nature of collaborative storytelling and to shift as those involved feel comfortable.

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| Volume 11, Issue 5, May 2024 |

Woman landowner Paulina's work with CE demonstrates the need to keep these items aligned. Her first scenario centered on her own farm. Her second started that way but shifted when she noticed two specific conservation projects that were implemented in an ideal location uphill (toward the top of the visualized landscape), preventing degradation below that area. At that moment, her exploration expanded to the larger scale of watershed dynamics:

I'd like to learn more about watersheds and exactly how much manure runoff affects water quality. Because by what I've researched, [the state's agriculture and stewardship department] is funding projects in twelve watersheds. We have two fields that are in the —— Watershed, and in parts of those fields—through the years—we've been able to do some improvements to improve runoff from our fields, but the problem is much larger than what happens on our individual fields.29

As she began to move back and forth between her fields and the larger watershed, she likened the overwhelm of the watershed scale to that of climate change itself: "In our community, water quality's a big deal; we have a lot of people that are very committed to taking care of their environment. Many people get overwhelmed by the doom-and-gloom scenario about climate change. 'What do I do now? What do I do this week?' So we need to break it down into manageable bites. And that's not how we hear it, whether it's watersheds or climate change."30 Paulina gets right to the heart of what happens when the gap between the scale of environmental concerns (climate change, watersheds) and one's emotional and cognitive perception of agency is too large. Because her narratives involved scale, we introduced relevant narratives for her, using the watershed map that included her farm, and together we discussed the location of her land and the land in her county in relation to the different watershed scales. This moment exemplified the collaborative storytelling among experts, with each of us adding knowledge and perspectives. Paulina's emphasis on "manageable bites" further supports how the stories of climate change sometimes need to fit into smaller spaces. Paulina's action project expanded and diversified her use of cover crops, and she began looking into larger watershed issues with civic engagement steps in mind.

The gaps of multiplicity coupled with those of nonspecificity foster collaborative storytelling because they allow the exchange to evolve—often in ways in which social and environmental scales move and stretch in alignment. Equally important in this cocreated process, the impacts related to these larger scales cease to be unmentionable but instead become motivators that underscore the importance of local action. Such shared storytelling happened when woman landowner Diana and her husband were working together with researchers, WFAN facilitators, and CE. She and her husband initially imagined CE's abstract landscape as the farmland they own. Over the course of multiple runs, they progressively expanded their consideration of water flow, extending it to neighboring acreages and eventually to the larger watershed. Diana described this and another realization at a later storytelling session with the other women landowners: "One of my biggest ah-ha moments when using the model was that our neighborhood is at the top of our watershed, so what we do in our collective neighborhood is going to influence the area that much more. My other ah-ha moment was the importance of community in caring for the land. We want to create an opportunity to build these relationships in our neighborhood."31 These priorities around community and relationships underwrote Diana's action projects. Her first project addressed water flow on her land and engaged family in land stewardship; in her next project, she hosted a neighborhood ice cream social for the twenty-five households that, with her, have farms and acreages at the top of the watershed. She described her motivation for hosting this event: "So we don't have grand educational plans with our ice-cream social but hopefully starting with the conversations and neighbors getting to know each other. It's not just about me as an individual to know the right things or do the right things or all of this, but it's about that broader [2,3,4]community effort."32 When Diana signed up for the learning circle only months before, she was a newcomer to conservation; now she has become a local facilitator of conversation and conservation in a midwestern area that plays a significant role in mitigating the environmental degradation that will only intensify with climate change. Gaps of multiplicity allowed her to work on narratives that started with the familiar and led to environmental action on a larger scale than she would have ever imagined. Diana's expertise is community building, so the ice cream social as her action project grew out of her strengths, just as Paulina's thoughts about civic engagement and watershed issues fit her own expertise in civic matters. The language of stewardship and climate entered each of their narratives differently and emerged as different action.

Our collaborative storytelling with the neighborhood group had a different path. The twelve members divided into three smaller subgroups to work with researchers, community partners, and CE. Each group independently created scenarios by imagining CE's landscape as their group's shared property. After running a few scenarios, all three subgroups began to expand the scale of their discussion but in different ways. One group expanded its associations geospatially. One participant observed, "This reminds me about what is happening in the Gulf of Mexico,"33 so the group then did two simulations that imagined the upper part of the model's landscape as Iowa and the lower part as the Gulf of Mexico—

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| Volume 11, Issue 5, May 2024 |

exploring the implications that choices made upstream in the Mississippi River watershed have on the Gulf. Another subgroup started with its interest in local property but then began to think about how the participants' choices could impact and even inspire their community relationships with other neighborhoods and the city itself. These groups explored scenarios involving significant climate impacts, but the exploration helped them realize the social and regional importance of what they were doing, making the backdrop of climate change and watershed dynamics not overwhelming, as it so easily can be, but empowering. What's more, when they got back together as a large group, the topic of biodiversity that had emerged in two of the three small groups reemerged to increase their commitment to their waterwise project, now with an added focus of providing local habitat. Participants are now mentoring others in local urban sustainability; their reach and network continues to expand.

With students—both at the lower levels and university—the gaps between multiple narratives fostered shifts in scale but also involved a focus distinct to them: environmental justice. One student group member explained,

The simulation obviously gets me thinking about erosion, floods, pollution, and climate change, but I could not help but lose track of the problem as a readiness issue to find myself looking at a poverty problem. Each variation of the situation shows a different community, varying in location and level of income. Maybe it is because of the book that I am reading right now, Heat Wave, but I was constantly looking at the rounds of the simulation as separate communities experiencing the same issue.34

This group's approach to multiplicity is another way gaps provide significant learning opportunities for all involved; researchers never imagined approaching separate runs as exploring issues of equity within the same community. This student included a nod to another facet of interweaving more narratives into the story when he mentioned Heat Wave. Many students refer to texts they have read in other courses, such as Rob Nixon's Slow Violence for issues of inequity and Linda Hogan's Solar Storms for kinship among the human and more-than-human realm practiced in Indigenous cultures. Expansion and interweaving are precisely what we encourage, and the final type of narrative gap moves emphatically to the most radical aspect: that of revision. Gaps of revision openly invite individuals to transform the stories of research.

Gaps of Revision

With the gaps of revision we ask groups to share what they believe the model does not tell—or tell adequately—but should. This act draws out stories of those—human and more-than-human—who might have been silenced or disempowered. It uncovers our biases and blind spots as researchers and challenges the obscured logics that algorithms can impose. The gap of revision involves community individuals as fully transformative collaborators, able and encouraged to change the narratives of research. It is the most complicated of the three types of gaps and involves several steps.

The process for this gap begins with cultivating in community collaborators a critical stance to using simulation models that acknowledges and questions model design and output. To move from such critical inquiry to revision for action, we draw from community-based, activist performance practices, notably the Theatre of the Oppressed (TO) and Climate Change Theatre Action (CCTA).35 Both CCTA and TO reject the notion of spectators as passive viewers and emphasize instead collaborative storytelling for action. In TO spectators become spect-actors who contribute ideas that revise a given scenario or, in some activities, take over telling parts of the story themselves.36 For CCTA, events can occur within contexts that place the storytelling directly alongside local and immediate opportunities for action. In CCTA and TO, participants are expected[5,6,7] to move from watching narratives to joining their action to empower change. The collaborative act of storytelling is geared toward prompting transformative intervention.

Researchers often serve as the first revisionists by indicating how CE's narratives are inadequate to capture the narratives of research. These additions often begin with the hidden stories of "life overlooked"—such as those of CE's small and unassuming dragonflies and mayflies and the vibrancy of the microbial life in the soil itself.37 Because the mayflies and dragonflies are depicted explicitly on CE's interface, their story is more visible, and there is brief text on the lower right of the interface that links the presence of these two often-unnoticed species with ecosystem health. Groups often ask why those two species are included because, they admit, they have never thought much about them (other than the beauty of the dragonflies). These questions invite researchers, or ideally someone else in the group, to share the story of these small species so crucial to, and indicative of, ecosystem health. One of our conservationist partners emphasized the importance of using these two species to cultivate individuals' art of attentiveness and the need for indicator species tied to ecosystem health.38

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| Volume 11, Issue 5, May 2024 |

Another hinted-at story underwrites why the simulated native prairie flowering plants absorb the runoff and stop the erosion. In CE the rain agents simply disappear when they encounter this vegetation, and the graph quantitatively registers improvements in water quality and erosion. But there is no explanation. Underneath the simplicity of the visualized process are powerful stories of soil—exchanges among roots, fungi, bacteria, and minerals. The part of the prairie plant above the ground is the only visible part of the larger underground story of vast microbial networks surrounding root systems that can reach down twenty-five feet. Most people we have worked with have never considered this vast network.

Sharing these hidden, untold stories opens the conversation to what other quiet or omitted stories need to be told—particularly those of lives overlooked or silenced through systemic inequities. When time permits or the opportunity arises, we ask groups to share what CE needs to include or outright revise. For example, CE glaringly omits issues of environmental justice. On the interface all human agents are affected equally, with no acknowledgment that individuals who occupy the space downhill/downstream bear the impacts of choices made by individuals uphill/upstream. Students often address this need for revision, emphasizing

- the need to hear the voices of Indigenous and other disenfranchised populations
- the reality that some areas naturally receive either full or only limited access to water and/or the conservation efforts implemented ("What if only one part of the place received [the actual water from] the rainfall? What if one part of the place was protected from too much rainfall? What if no matter what they [some 'ready' people] did, their subcommunities could not benefit from their work?")
- the lack of human agents "in direct opposition to the changes being made, such as special interest groups or big business that profit from releasing sediment into the rivers. What would their sway be?"39

With these suggestions we do not modify CE to "get it right" the next time. We are not trying to build a more realistic model or be better, more complete storytellers ourselves. We intentionally will not fix the depiction of the human agents to have the downhill/downstream individuals suffer the impacts from uphill/upstream humans' actions. Rather, we want people to be annoyed, [8,9,10]to change the narrative, to take charge of it. Like TO's Forum Theatre activities, we want the spect-actors to, essentially, call out "Stop!" in the scenarios that are not right, step in to change the story, and revise it to make it more inclusive, more just, more nuanced. And with that revision take a step that contributes to making that story reality.

Our most powerful example of using the gaps of revision comes from the women landowners. Hearing their stories, we recognized how CE's depiction of what constitutes conservation action is too narrow, even overtly disempowering, because it represents conservation action primarily as the act of planting. These women own the land; their tenants are the ones who put "roots in the ground." The women's disconnection from the land sometimes hinders them from feeling empowered to push for conservation practices on their own land. Therefore, in an additional group session we asked the women to challenge and revise this representation in CE. Their responses revealed how an emphasis on planting as conservation privileges certain systems that are already present in the divisive and hierarchical language of "operator"/"nonoperator" that presupposes and negates their agency (as nonoperators) and that carries a land-dominance mindset. The women's ideas have prompted us to advocate that agriculture replace operator/nonoperator terminology with that of "stewardship partners" and expand conservation outreach and programming to more pointedly support relationship building—a paradigm practiced by Indigenous populations for centuries.40 As these women corrected and expanded the model's representation of conservation action, their insights added to and sharpened the existing wisdom our group of facilitators and women landowners created together—wisdom shared in the article our full group produced as coauthors.41 The collaborative storytelling with these women was distributed among all of us; our narratives truly entered and transformed each other.

Minding the gaps is about leaving space for others to join and own the story. To help our particular team share the narrative-making, we used a conventional tool of Western, modern science, a computer-simulation model (CE), to counter the paradigm of researchers as the primary storytelling experts. Our interest, however, is not to advocate for use of the CE model and its more Western science–based assumptions but rather for minding the gaps as a larger practice that goes beyond different epistemologies coexisting. Intentionally integrating gaps in storytelling allows epistemologies to weave together: the narratives of climate resilience become part of the everyday stories people tell. Time and time again, we have had individuals start the storytelling process believing they know too little or see no meaningful entry points for action in large-scale scenarios of climate change presented in the media and research reports. By engaging in a process that includes their memories and experiences, they see how the building blocks of

action that contribute to climate resilience may have been in their stories all along. Now climate action grows out of the stories of their own life stories.

Although this process is energizing, we admit that we researchers still find it challenging to practice. Reciprocal storytelling requires us to step out of our epistemic comfort zones to actively invite plurality and uncertainty. It invokes an intensity of collaboration much like what Noel Castree calls for in transdisciplinary work—for scholars not "merely to collaborate but to unsettle each other."42 In our work, communities become part of the unsettling, which requires a willingness to be vulnerable and to trust. This brings us back to Hulme's emphasis on gaps in climate change knowledge as places of brittleness. They are spaces that involve unknowns. As such, they are inherently weak even as they can be used to invite the conversation and layering of diverse knowledges that could form a strengthening web of joined narratives.

Minding the gaps offers a way to acknowledge vulnerability and uncertainty as the dynamic places for collaboration and interdependence. As such these sites become loci for responsibility that require turning—continuously—outward from the solidity of one's own perspectives to engage in the larger knowledge ecosystems that surround us, including those of the more-than-human. It is about humility and kinship. It is about allowing what we do not know to be a strength that urges us to collaborate. Kinship and responsibility through uncertainties is precisely what climate collaboration needs to embrace.

III. RESULTS

The environmental humanities (also ecological humanities) is an interdisciplinary area of research, drawing on the many environmental sub-disciplines that have emerged in the humanities over the past several decades, in particular environmental literature, environmental philosophy, environmental history, science and technology studies, environmental anthropology,[1] and environmental communication.[2] Environmental humanities employs humanistic questions about meaning, culture, values, ethics, and responsibilities to address pressing environmental problems. The environmental humanities aim to help bridge traditional divides between the sciences and the humanities, as well as between Western, Eastern, and Indigenous ways of relating to the natural world and the place of humans within it. The field also resists the traditional divide between "nature" and "culture," showing how many "environmental" issues have always been entangled in human questions of justice, labor, and politics. Environmental humanities is also a way of synthesizing methods from different fields to create new ways of thinking through environmental problems.[3]

Emergence of environmental humanities

Although the concepts and ideas underpinning environmental humanities date back centuries, the field consolidated under the name "environmental humanities" in the 2000s following steady developments of the 1970s, 1980s, and 1990s in humanities and social science fields such as literature, history, philosophy, gender studies, and anthropology. A group of Australian researchers used the name "ecological humanities" to describe their work in the 1990s; the field consolidated under the name "environmental humanities" around 2010.[4] The journal Environmental Humanities[5] was founded in 2012 and Resilience: A Journal of the Environmental Humanities[6] in 2014, indicating the development of the field and the consolidation around this terminology.

There are dozens of environmental humanities centers, programs, and institutions around the world. Some of the more prominent ones are the fully funded[7] Environmental Humanities Graduate Program at the University of Utah, the oldest environmental humanities graduate program in America,[8] the Rachel Carson Center for Environment and Society (RCC) at LMU Munich, the Center for Culture, History, and Environment (CHE) at the University of Wisconsin–Madison, The Center for[8,9] Energy and Environmental Research in the Human Sciences at Rice University, the Penn Program in Environmental Humanities at the University of Pennsylvania, the Environmental Humanities Laboratory at KTH Royal Institute of Technology, The Greenhouse at the University of Stavanger, and the international Humanities for the Environment[9] observatories.

Dozens of universities offer PhDs, Masters of Arts degrees, graduate certificates, and Bachelor of Arts degrees in environmental humanities.[10] Courses in environmental humanities are taught on every continent.[8]

The environmental humanities did not just emerge from Western academic thinkers: indigenous, postcolonial, and feminist thinkers have provided major contributions. These contributions include challenging the human-centered viewpoints that separate "nature" and "culture" and the white, male, European- and North American-centric viewpoints

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| Volume 11, Issue 5, May 2024 |

of what constitutes "nature"; revising the literary genre of "nature writing"; and creating new concepts and fields that bridge the academic and the political, such as "environmental justice," "environmental racism," "the environmentalism of the poor," "naturecultures," and "the posthuman."[4]

Connectivity ontology

The environmental humanities are characterised by a connectivity ontology and a commitment to two fundamental axioms relating to the need to submit to ecological laws and to see humanity as part of a larger living system.

One of the fundamental ontological presuppositions of environmental humanities is that the organic world and its inorganic parts are seen as a single system whereby each part is linked to each other part. This world view in turn shares an intimate connection with Lotka's physiological philosophy and the associated concept of the "World Engine".[1] When we see everything as connected, then the traditional questions of the humanities concerning economic and political justice become enlarged, into a consideration of how justice is connected with our transformation of our environment and ecosystems. The consequence of such connectivity ontology is, as proponents of the environmental humanities argue, that we begin to seek out a more inclusive concept of justice that includes non-humans within the domain of those to whom rights are owing. This broadened conception of justice involves "enlarged" or "ecological thinking", which presupposes the enhancement of knowledge sharing within fields of plural and diverse 'knowledges'. This kind of knowledge sharing is called transdisciplinarity. It has links with the political philosophy of Hannah Arendt and the works of Italo Calvino. As Calvino put it, "enlarge[s] the sphere of what we can imagine". It also has connections with Leibniz's Enlightenment project where the sciences are simultaneously abridged while also being enlarged.[2]

The situation is complicated, however, by the recognition of the fact that connections are both non-linear and linear. The environmental humanities, therefore, require both linear and non-linear modes of language through which reasoning about justice can be done. Thus there is a motivation to find linguistic modes which can adequately express both linear and non-linear connectivities.

Axioms

According to some thinkers, there are three axioms of environmental humanities:

1. The axiom of submission to ecosystem laws;
2. The axiom of ecological kinship, which situates humanity as a participant in a larger living system; and
3. The axiom of the social construction of ecosystems and ecological unity, which states that ecosystems and nature may be merely convenient conceptual entities (Marshall, 2002).

Putting the first and second axioms another way, the connections between and among living things are the basis for how ecosystems are understood to work, and thus constitute laws of existence and guidelines for behaviour (Rose 2004).

The first of these axioms has a tradition in social sciences (see Marx, 1968: 3). From the second axiom the notions of "ecological embodiment/ embeddedness" and "habitat" have emerged from Political Theory with a fundamental connectivity to rights, democracy, and ecologism (Eckersley 1996: 222, 225; Eckersley 1998).[10]

The third axiom comes from the strong 'self-reflective' tradition of all 'humanities' scholarship and it encourages the environmental humanities to investigate its own theoretical basis (and without which, the environmental humanities is just 'ecology').

IV. CONCLUSION

Contemporary ideas

Political economic ecology

Some theorists have suggested that the inclusion of non-humans in the consideration of justice links ecocentric philosophy with political economics. This is because the theorising of justice is a central activity of political economic philosophy. If in accordance with the axioms of environmental humanities, theories of justice are enlarged to include ecological values, then the necessary result is the synthesis of the concerns of ecology with that of political economy: i.e. political economic ecology.

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| Volume 11, Issue 5, May 2024 |

Energy systems language

The question of what language can best depict the linear and non-linear causal connections of ecological systems appears to have been taken up by the school of ecology known as systems ecology. To depict the linear and non-linear internal relatedness of ecosystems where the laws of thermodynamics hold significant consequences (Hannon et al. 1991: 80), Systems Ecologist H.T. Odum (1994) predicated the Energy Systems Language on the principles of ecological energetics. In ecological energetics, just as in environmental humanities, the causal bond between connections is considered an ontic category (see Patten et al. 1976: 460). Moreover, as a result of simulating ecological systems with the energy systems language, H.T. Odum made the controversial suggestion that embodied energy could be understood as value, which in itself is a step into the field of Political Economic Ecology noted above.[10]

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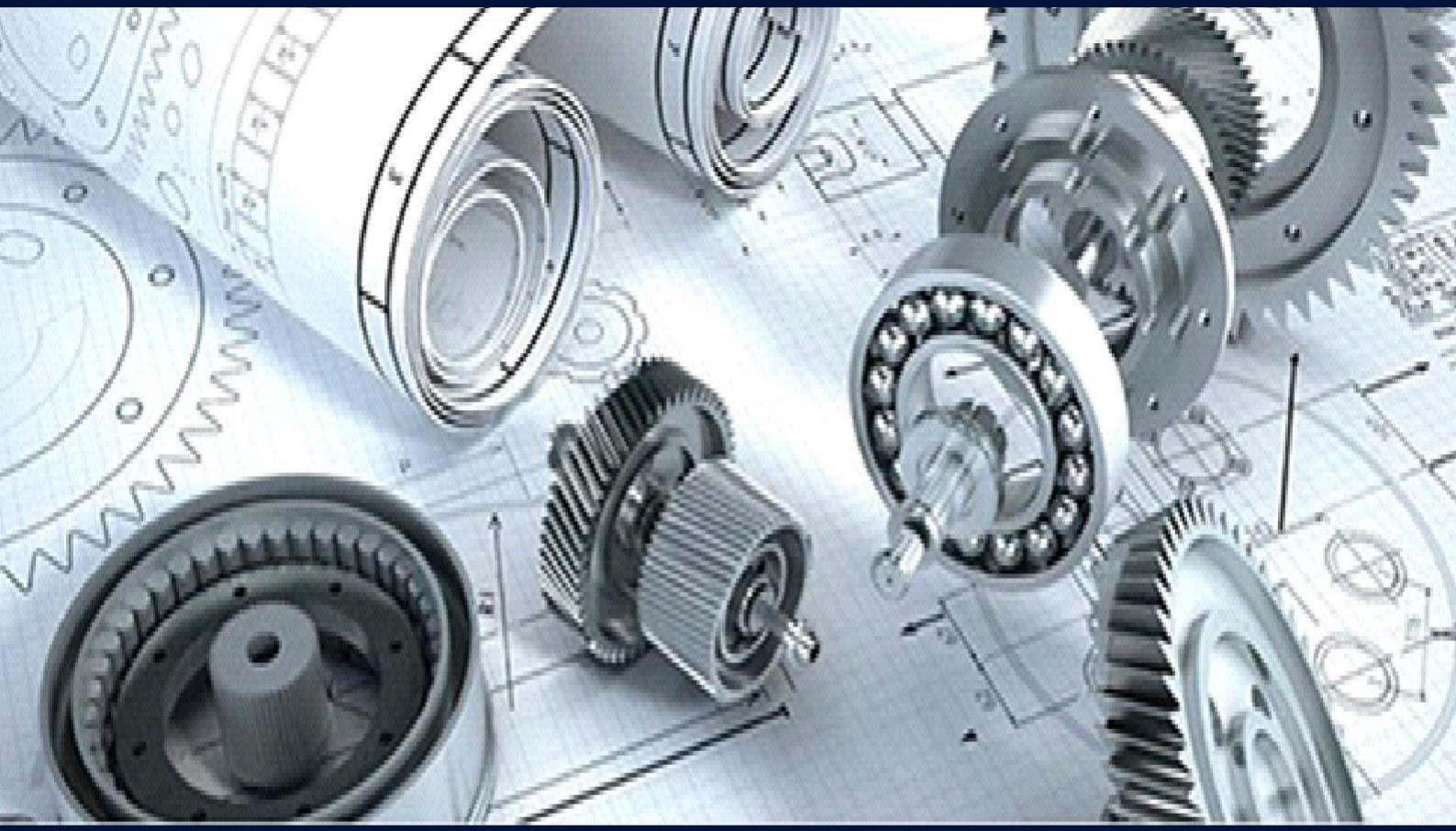

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