The Science of Climate Change: A Love Story

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As climate leaders gathered in conference rooms and auditoriums for the COP 26 meetings last summer in Glasgow, Scotland, to discuss the world's response to climate change, scientists continued to provide stunning information about the fate of the world affected by climate change. This is what we know unequivocally: Our world is changing in ways that far exceed the natural rate of variability. These changes are not only harming living human beings, but they will also create an ever more unstable and dangerous world for future generations. These impacts on humans living and those yet to live in this dimmer future are differential—affecting the historically marginalized far more than those responsible for climate change in the first place. Author and activist Heather McGhee calls it the "one-two punch of climate change… where our extractive predatory economy has stripped wealth and resources from communities of color and poor communities around the world, and is now leading to climate change impacts that disproportionately affect those same communities."

Because humans—and especially those of us in developed countries—are responsible for the creation of this reality and because we are able (but refuse) to address climate change, we have created a human moral harm of monstrous proportions. There are no adjectives to adequately capture the full force of this moral wrong.

It is worse than that, as well. The moral harm of climate change extends also to the impacts on all living beings in the world. Beyond even that, climate change is affecting the world's ecosystems, causing a great unraveling of global ecological support networks.

The HJ Andrews Experimental Forest, in Oregon's Cascade Mountains, is part of the Long-Term Ecological Research (LTER) program, a network of 28 sites around the country. The LTER program was created by the National Science Foundation in 1980 to study the ecosystems of the United States—from old-growth forests to coastal barrier landscapes, from urban centers to the Antarctic dry valleys. For more than 40 years, LTER researchers have witnessed wonderous stories about how those incredible ecosystems function and about how climate change is affecting them. And the message is clear: From all 28 LTER sites, we know that climate change is affecting every single part of those ecosystems.

This story is powerfully illustrated in a collection of papers in this issue of *BioScience*. Jones and Driscoll (2022) demonstrate that "At all 28 LTER sites… air temperature and moisture variability have increased since 1930, with increased disturbance frequency and severity and unprecedented disturbance types." Focusing on a decade of research from coastal ecosystem LTER sites, Reed and colleagues (2022) show how "climate change is altering their ecological structure and function, as well as their highly valued goods and services." Hudson and colleagues (2022) synthesize more than 40 years of research from eight dryland sites revealing that while periods of warming and drought differed between sites, all sites exhibited warming," that "climate change affects primary production in dryland US LTER sites in many ways," and that "interactions among climate drivers, such as heat waves combined with drought, often produced greater responses of primary production, community structure, and ecosystem services than changes in individual climate drivers." In Campbell and colleagues (2022), we learn that research from nine forest and freshwater ecosystems reveals that "climate change is affecting their species composition, structure, and function," including increased air temperatures at all sites, variable changes to moisture regimes, alteration of streamflow and ecosystem processes ("including primary production, carbon storage, water and nutrient cycling, and community dynamics"), with climate change even becoming "the dominant driver altering ecosystems" at some sites. Finally, Ducklow and colleagues (2022) present long-term research revealing how climate change is variably affecting the many dimensions of five marine coastal sites.

A funny thing happens when researchers spend decades studying ecosystems; they begin to fall in love. One Andrews Forest LTER researcher explains her commitment to the Andrews Forest as "an irrational love of the forest." A poet in residence reflects on the ropes, flagging, stakes, sediment ponds, and temperature gages used by researchers in the forest and concludes that these items are proof that "somebody loves this place."

Our knowledge, our love, and our privilege carry a corresponding

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responsibility. It is the obligation of the US LTER program (and perhaps all environmental scientists with similar knowledge of and love for what they study) to directly address climate change in at least two ways.

First, at a minimum, we are obligated to describe, systematically and fully, the impacts of climate change on the ecosystems that we are uniquely poised to understand. Fulfilling this obligation means that we must turn the full power and force of our science toward explaining climate change impacts on our systems. What else could be more important at this time in Earthly history? As Indigenous scientist and writer Robin Kimmerer asks, "Our relationship with land cannot heal until we hear its stories. But who will tell them?" We are the storytellers for our ecosystems, and we owe it to them to tell their stories. There is no healing without revealing and sharing these stories.

Second, our obligations go beyond merely describing the conditions of the ecosystems that we know and love. If we truly do love those ecosystems and if the object of our love is under threat, what more does this demand of us? Merely providing information about how our ecosystems are being affected by climate change is critical but not enough to fulfill our moral obligation to those systems, any more than describing the process of a friend dying from COVID is enough to demonstrate care for that friend. Information is not enough to prompt action, because prescriptions for action cannot, logically, be derived from information alone. Nor is information enough to fulfill the full range of our obligations to our ecosystems. We are obligated, morally, to openly advocate on their behalf. In the words of philosopher and writer Kathleen Dean Moore, "Loving is not a kind of *la-de-da*. Loving is a sacred trust. To love is to affirm the absolute worth of what you love and to pledge your life to its thriving—to protect it fiercely and faithfully."

What does it mean to love and care for the Andrews Forest? It means you share the forest's story not only in scientific publications but publicly. It means sharing not only what we learned *about* the forest but what we learn *from* the great teacher as well. It means abstracting outward: To learn the story of the Andrews Forest is to realize that all old-growth forests, all forests—indeed, all ecosystems—also have stories. It means to tell those stories, to speak for those ecosystems, to speak on their behalf. It means telling the story of the forest but as a love story. It means speaking truth to political power and industries of destruction. It means not hiding behind the false shield of objectivity. It means not shushing colleagues who speak out by issuing threats to their credibility. It means realizing that responding to the challenge of the climate crisis requires all dimensions of the human imagination, requiring deep collaborations among scientists, writers, philosophers, artists, and beyond. It means realizing, too, that to fight the climate crisis is to fight racial and social injustice. In summary, it means anything but business as usual, a guarantee of failure.

"Listen to the science" urged President Biden and John Kerry at the COP 26 meetings. Yes, listen to the science, but know that science alone cannot save us. Listen also to our love for the world. Listen also to the suffering of the impoverished and disenfranchised, and the future. Notice that we are witnessing, as Pope Francis puts it, the mutually entwined "cry of the Earth and the cry of the poor."

Our love and our knowledge create a new kind of work for us in the face of the climate crisis. Beyond the work of revealing and explaining our ecosystems, we are called also to do the work of caretakers for those ecosystems. That new work must begin right now. This is an urgent call for the US Long-Term Ecological Research Network and all environmental scientists to more directly engage the climate crisis.

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