From Pleistocene to Pyrocene: Fire Replaces Ice

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Key Points:

- Terrestrial fire is a unique feature of Earth, and fire uses a unique marker of human activity.
- A major inflection in human fire history occurred when people turned to burning fossil biomass rather than living.
- The combined effect is to create the fire equivalent of an ice age—a Pyrocene.

Abstract

Fire offers a special perspective by which to understand the Earth being remade by humans. Fire is integrative, so intrinsically interdisciplinary. Fire use is unique to humans, so a tracer of humanity’s ecological impacts. Anthropogenic fire history shows the long influence of humans on Earth and even climate; in particular, it tracks the continuities between the burning of living landscapes and the transition to burning lithic (fossil) ones, an inflection so immense that climate history is now a subnarrative of fire history. Through our varied burnings, humans are driving out all the relics of the Pleistocene and replacing them with fire equivalents, or in short, creating a Pyrocene.

Plain Language Summary

The history of anthropogenic fire offers a useful way of understanding the Anthropocene. It provides a continuous narrative, particularly for the transition into the burning of fossil biomass, and it proposes an analogue—the fire equivalent of an ice age—by which to imagine the future.

1. Commentary

Fire—that other contagion, the one with no vaccine—seems everywhere. Flames gnaw into forest, savanna, and peatland, from the Amazon to the Arctic, and everywhere they are used to illustrate a human-sparked breakdown in the Earth System. In particular, megafires have joined the forlorn polar bear as an emblem of a climate crisis (e.g., Kodas, 2017; Struzik, 2017). Yet fire is typically presented as something that happens because of other, more elemental drivers, and because it synthesizes the scene around it, its understanding is likewise dispersed into a cluster of subdisciplines of more fundamental sciences. It seems to have no intrinsic presence or scholarship of its own (Pyne, 2016).

It is possible, however, to pick up the other end of the stick and make fire’s intrinsic interdisciplinary a means of integrating much of what characterizes the Anthropocene. Humans are the keystone species for fire on Earth, and our ability to manipulate fire is our unique ecological signature. What does history look like if fire moves from vignettes decorating the main text to the informing narrative? What if we tell the story not as a broad-brush Anthropocene or interglacial Holocene, but as a Pyrocene?

The Earth is a uniquely fire planet with a chronicle of fire that extends to the onset of terrestrial life (Scott, 2018). Humans are a uniquely fire creature whose genus more or less spans the Pleistocene. Certainly, Homo erectus had fire; by the end of the last glaciation, only Homo sapiens did (Goudsblom, 1992; Gowlett, 2016; Wrangham, 2009). A species monopolist, it remade its genome by cooking food; remade biotas by cooking landscapes; and is remaking the planet by slowly cooking the Earth. The human firestick has become an Archimedean lever (Scott et al., 2015).

The interaction gained traction when a fire-wielding species met a fire-receptive world—the rapid warming after the last glacial maximum. The Holocene effectively announces the onset of a Long Anthropocene, or defining the epoch by humanity’s power source, a Pyrocene, a time when humanity’s firepower could interact in ways that promoted conditions that favored further fire (Stephen et al., 2020). The more fire could render resources accessible, the more it was used, and the more receptive to fire land often became.

What fire did not directly affect, it influenced indirectly by amplifying humanity’s reach, if not its grasp. Much of humanity’s technology involves fire at some point in its chain of creation. People cooked stone to make cement, sand to make glass, ores to make metal, wood to make pitch and tar, mud to make brick. With fire they broke rock, hardened spears, and excavated dugouts (e.g., Smith & Gnudi, 1990). Around fires they told the stories that helped transform a material world into a symbolic one (e.g., Weissner, 2014).
In aboriginal economies people could both drive and attract game for seasonal hunts. They could bait traps with fresh grass, lure fish with flame, smoke out hives, prune berries, open routes of travel, and generally “clean up” the countryside (e.g., Anderson, 2013; Gammage, 2012; Jones, 1969). In agricultural economies they could slash and burn woods, shrubs, and peat, and then plant cultivars in the ash; could burn moor, savanna, and woodland to stimulate forage for livestock; could, with a properly timed burn, coax fallow and wasteland into arable (e.g., Sigaut, 1975; Steensberg, 1993). Of course, fire wasn’t everything, but it could seem everywhere as cause, consequence, and catalyst.

As the interaction broadened and quickened, bit by bit, it had global consequences. It could even influence climate through the carbon cycle (e.g., Ruddiman, 2005). Aboriginal fire stalled forests from reclaiming many grasslands. Agricultural fire rolled back forests and shrubs and burned away peat and marshlands. Some fascinating research has even correlated the demographic collapses in Eurasia in the 14th and 15th centuries, and those in the Americas in the 16th and 17th, with the onset of the Little Ice Age (e.g., Dull et al., 2010; Koch et al., 2019). Carbon once released re-sequestered. A mild greenhouse effect evaporated. It remains to convert coincidence into cause, but the scale of fire-enabled transformations can hardly be doubted.

Yet because all of these interventions happened in living landscapes, they operated within ecological checks and balances. Fires occurred when environmental conditions permitted; people could shift and tweak those conditions—could, for example, transform a wood that could not burn into one that could. But burn too deeply or recklessly and the resulting conditions could change in ways that made future burning more difficult or dangerous. The land could become less habitable.

Humanity evaded these constraints by turning to lithic landscapes—fossil biomass—as a source of fuel (e.g., McNeill, 2000; Smil, 1994). Suddenly, the old barriers and baffles were gone. Because combustion happened in special chambers, it was possible to burn at any time, in any hour, season, or year. The source of combustibles became unbounded, and with it humanity’s firepower. The problem was sinks. The traditional reservoirs to hold and recycle fire’s effluents were overloaded. The atmosphere overflowed with greenhouse gases. Oceans acidified. And humanity traded its ancient fire arts for newer models, putting less fire on the land (Pyne, 2019a, 2019b).

This had benign outcomes in built environments. Homes, offices, factories, all replaced working flames with surrogates, most powered by burning fossil fuels. Then the practice extended into the countryside. Increasingly, agriculture replaced the effects of open burning with chemicals drawn from fossil biomass and machines charged by industrial combustion. Even in wildlands, free-burning flame was challenged by counter-burning from combustion-powered machines.

These transitions were not so benign. Fire’s removal from places that had adapted to it kindled a cascading ecological disruption that has gone beyond replacing quasi-tamed fire with feral flame and widened into an ecology of emptying sources and overfilling sinks and an interglacial that is inflecting into the fire-informed equivalent of an ice age.

The dialectic between living landscapes and lithic ones changed how the keystone species for fire lived on and exploited lands and waters, and interacted with other species. This pyric transition to fossil fuels has prompted a world with too much of the wrong kind of fire, too little of the right, and too much combustion overall.

Climate change and its knock-on effects are the best-known expressions. But the consequences were felt well before climate change became unmistakable, in fact at a time when climatologists were forecasting the inevitability of a new ice age. The abrupt removal of fire, both natural and anthropogenic, in many rural landscapes and public wildlands was manifesting itself in terms of massing fuels and deteriorating ecosystems (e.g., Tall Timbers Research Station, 1962–present). In the United States the problem led to a revolution in ideas and institutions. In 1968 the National Park Service renounced a suppression-only policy in favor of fire’s restoration; in 1978 the U.S. Forest Service reorganized for the same purpose (Pyne, 2015).

But why is this an offshoot of fossil fuels? Because without the aircraft, the bulldozers, the crew-carrying vehicles, the chain saws, and pumps, it would not be possible to attempt to control all those fires or to offer surrogates for them. (Even prescribed burns are done with drip torches that ignite gasoline-diesel mixes.) Instead, agencies would have to do what people have always done: they would have to manage the
vegetation and replace wild fires with tame ones. The amount of burning would be different, but fire would have remained on the landscape and at scale. Only an industrial society could have pretended to abolish fire in the countryside as it did in cities.

Put differently, fire synthesizes two groups of factors. One collects grand geophysical conditions like terrain and climate. The other pertains to vegetation that feeds the flames; unlike disturbances such as hurricanes or floods, which can occur without any particle of life present, fire cannot exist without a matrix of living biomass (McLaughlan et al., 2020). Historically, humans had to work around or sometimes with the first group, but they could manipulate the second by burning, cutting, farming, draining, herding, and endless acts of tinkering. By overlaying the living landscape with a lithic one—taking fossil biomass out of the geologic past, burning it in the present, and releasing its byproducts into the geologic future—they now influence both groups. Behind both lies the pyric transition to a fossil-fuel civilization (Balch et al., 2016).

At first the two realms of combustion did not play well together. Industrial fire tends to drive off its rival. Evening satellite images of the Earth at night aptly show the two distinct dominions (Figure 1). The competition, however, occurs at particular places. What happens in, say, Florida does not affect the fire scene in California except indirectly through national institutions like forestry bureaus or economic networks that can influence fire’s presence in both places—for example, by encouraging land clearing or land abandonment.

By shaping how people live on the land, industrial combustion affects what exists to burn, how fires might harm communities, and how people imagine fire around them. An apt illustration of how the two realms can intersect with fatal outcomes are the wildfires started by powerlines that fail during high winds. Still, the changes wrought by the transition to industrial combustion were sufficient to account for a reduction in anthropogenic burning worldwide and to alarm the wildland fire community many decades ago. Biomes degraded, and fuels upgraded.

Paleofire researchers note a break in the historic linkage between climate and burning in the latter 19th century, paradoxically about same time the Little Ice Age ended (e.g., Andela et al., 2017). The instinctive expectation is that, with renewed warming, fire’s climatic signal would strengthen. Instead, landscape fire and climate began to decouple. Of course, big fires resulted when the air was hot, dry, and windy, but the magnitude and character of fire shifted. Markets made possible by locomotives and steam ships quickened landclearing and logging in forests, which swelled with megafires powered by the slash left behind. The Adirondack Mountains, for example, burned 600,000 acres in 1903, and another 400,000 in 1908 (e.g., Suter, 1904). Like a population explosion followed by demographic collapse, that wave of fires then passed to a world whose fires fell below the replacement value needed for ecological integrity. In the arid American West railroads stimulated immense herds of livestock, which stripped away the grasses that had historically carried frequent fire (e.g., Allen, 2002). Landscape fire and climate still interacted—there was no way they could not. But more and more insistently people outfitted with industrial combustion set the terms of engagement (e.g., Figure 2).

Meanwhile, the effluent of fossil fuel combustion—now larger in fuel volume than that from burns in living landscapes—marinated the

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**Figure 1.** The contrast between Europe and Africa at night shows the two realms of combustion. Europe is not wholly illuminated by fossil fuels, but it is a fossil fuel civilization. Subsahara Africa mostly burns living landscapes. Gas flares appear in deserts and off shore. The two realms do not overlap, or do so only through a transitional phase. Image courtesy of Chris Elvidge, processed by the NOAA National Geophysical Data Center.

**Figure 2.** Where the two realms meet: the Trans-Alaska pipeline and Aggie Creek fire outside Fairbanks, Alaska. Photo by Philip Spor, courtesy Alaska Department of Forestry.
atmosphere with greenhouse gases. Climate changed, and the influence of industrial combustion went global. Its consequences are felt everywhere, whether or not a place has a history of landscape fire. It affects the oceans, melts glaciers, and works with fires to reorganize and relocate biogeography. With a changed climate, the two realms of combustion no longer compete so much as they collide. Those places that have a history of landscape fire (think Australia) are experiencing bad fires more frequently, more widely, and with greater savagery. Those places that have had fires only because people put them there (think central Europe) are seeing wildfires move from historical anomalies into an almanac of annual threats (Bowman et al., 2020).

Put all those fires together, and we have an Earth more and more informed by burning, and that through burning becomes prone to further burning. The analogy to an ice age looks more robust. Instead of ice sheets, pluvial lakes, permafrost, and outwash plains, there are fire-informed biotas, fire-famished ecosystems, melting permafrost, and megapalls of smoke. Instead of dropping, sea level is rising. Mass extinctions are underway. An interglacial, a span between outbreaks of ice, looks to become its own epoch, its varied burning overpowering the Milankovitch cycles that had set the majestic rhythms of the ice. All the cardinal features of an ice age are being replaced with fire equivalents. Climate history is becoming a subnarrative of fire history. The Pleistocene is segueing into a Pyocene.

It is not just that more wild fires will rage, but that fire—from living or fossil biomass, directly or indirectly through the fingaling hands of humanity—is reshaping the Earth. Call the outcome the Pyocene, and use the concept to understand how our present world works, how fire will likely function in the future, and how the appeal to fossil fuels as a generic energy source has rewired Earth’s energy circuits and biogeochemical cycles.

The concept of a Pyocene will not tell us what exactly that world will be. It does advance two features to help guide our choices. It offers a continuous narrative that links that uncertain future to our species-long relationship with fire, and it proposes an analogue that suggests how to picture the many outcomes. We have broken the rhythm of glacial and interglacial and are replacing a future ice age with a fire age.

The Pyocene can also serve as a research program. It suggests topics to study and ways to link them; the rapid conversion of China and India to fossil fuels is a contemporary example by which to test the pyric transition. Much as fire integrates its surroundings, so a fire-centric project can bring together many otherwise seemingly unrelated events and processes. Not least, the notion of a Pyocene identifies a prime mover, humanity. We remain the keeper of the flame, even if those flames are sublimated into machines. It is for us to decide if our ancient relationship with fire is a mutual-assistance pact or a Faustian bargain.

Data Availability Statement
My data are textual—the information and ideas contained in the references listed below. Where links for articles exist, I have provided them. I have not provided library links for books.

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