THE WILDERNESS SOCIETY

Rocky Mountain West:
The Interplay of Fire, Carbon Storage, Charcoal, and Global Warming
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Background: Given the early onset of wildland fire season in many parts of the Rocky Mountain West, combined with the heightened awareness of the issue of carbon storage and its relationship to global warming, this brief memo describes the interaction of fires and climate change – concluding that forest fires are a carbon neutral entity.

Historical Role of Fire: Fire is a natural process associated with all forest ecosystems of the Rocky Mountain West. Low to mid elevation ponderosa pine, Douglas-fir and larch ecosystems are considered to be fire maintained ecosystems that historically experienced non-lethal wildfires on a somewhat regular fire return interval. By comparison, higher elevation lodgepole pine and subalpine fir forests more commonly experienced high severity, stand replacing fires on a much broader return interval.

Climate Change and Fire: With climate change we are observing an increase in the length of the fire season and the frequency of fire events. So the question is often raised: will climate change result in additional carbon losses to the atmosphere from our forest ecosystems that will only increase warming in the future? One must first consider the nature of forest carbon and second consider the role of charcoal, a byproduct of fire, in this global carbon cycling picture.

Forests, Carbon Storage, and What Happens During a Fire: Because any losses to the atmosphere from a forest fire represent carbon that was fixed from the atmosphere in recent history, forest biomass is by nature a carbon neutral entity. During forest fires, a portion of the forest biomass (trees, shrubs, litter, and downed wood) is consumed in the fire and released into the atmosphere as CO_2, a portion remains behind as fire-killed biomass, and a portion remains as charcoal. In a fire, about 5 to 30 percent of the forest biomass is burned and converted to CO_2 and CO (both of which are greenhouse gasses). The fire killed (non-charred) biomass that remains on site is slowly converted to CO_2 by decomposition processes taking tens to hundreds of years depending size and nature of the biomass.

Charcoal and Carbon Storage: Charcoal is a ubiquitous byproduct of fire and is a uniquely stable form of carbon known to remain intact for hundreds to thousands of years in soil and for tens of thousands to millions of years in marine environments, thus serving as long-term storage of carbon. During a wildland fire event, about 1 to 10 percent of the forest biomass exposed to fire is converted to charcoal. Any of the charcoal buried in mineral soil and deposited in deep sea or lake sediments will remain stored in that form for far longer than the carbon stored in trees, shrubs, litter, or even in soil humus.

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Charcoal's Additional Benefits: In addition to carbon storage, charcoal also serves a number of beneficial roles in the forest ecosystem: charcoal adsorbs organic compounds in soil that may otherwise inhibit regeneration; charcoal increases soil water holding capacity; and charcoal also increases the amount of available nitrogen, a nutrient that improves forest productivity.

After a Fire: During the years after fire, rapidly regrowing forests consume atmospheric CO_2, converting it to plant biomass, slowly recapturing the carbon lost to the atmosphere during the fire event and in the decomposition of fire killed forest biomass. In a warming climate, increased decomposition rates of litter and fire killed trees would be observed (increased CO_2 output), but charcoal would remain as a recalcitrant substrate partially offsetting this ill effect of climate change.

Summary: Forest fires, regardless of climate change, are a carbon neutral entity. While climate change may increase the occurrence of fire, the burning of biomass in wildfire events will create only a short-term increase in carbon loading of the atmosphere. Regrowth after fire means that the forest ultimately recaptures most of the carbon lost to the atmosphere during fire (and subsequent decomposition processes). When considering the charcoal carbon stored in soils and aquatic ecosystems, the forest may be viewed as carbon negative because it stores away recently fixed carbon for thousands of years. Thus, in the long-term, forest exposed to fire may actually exhibit reduced long-term atmospheric carbon loading compared to forests not exposed to fire and the emissions during and after a fire reflect release from a carbon neutral or negative entity.