Frequently Asked Questions About:

The Case for Fire as a Nature-based Solution for Carbon Removal Projects in Africa

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Overview

A spate of recent studies demonstrate the massive potential and sound scientific underpinnings for fire management-based carbon projects to generate significant carbon removals both below ground (to soil) and above ground (to woody biomass) across the globe, but particularly in Africa. This document outlines some of the most frequently asked questions (FAQs) about fire management as the basis for establishing carbon removal projects. The answers are supported by a longer report that provides much more information on each question. Please consult the companion document should more information or explanation be required.

Frequently Asked Questions

1. What should I know about fire before thinking about carbon?

- **Think of fire as a disturbance process**. Disturbance processes can be characterized by the "prevailing agents" or types of disturbance[1]. Fire is characterized by the spatial, temporal, and magnitude of the fire event(s)[2,3]. Spatial extent is defined by size, temporal characteristics include frequency and seasonality, and magnitude is defined by intensity and severity[2,3,4] . The combined expression of these characteristics over time in a given location defines the <u>fire regime</u>[5]. *Fire management plans develop objectives focused on achieving a desired <u>fire regime</u>*.
- **More is known about types of disturbances than about how different disturbances interact[1,6] which is important in the context of climate change**. In many areas previous patterns of fire are changing, and it is uncertain how these changes are influenced by other disturbance processes, particularly climate change. This is why gathering data on fire regimes is essential to untangle the potential influence of other disturbances vs. fire management activities on achieving fire management objectives. *Fortunately, there is good satellite imagery that can track changes in fire regimes*[2].
- **Fire regimes vary significantly depending on the ecosystem type and other environmental variables**. Therefore, it is critical to look carefully at all the components of fire regimes within any given area. The different characteristics of fire regimes influence different carbon pools *Extensive fire analysis is essential in any fire management-based carbon project*.

2. How does fire affect soil and woody carbon in savannas?

- **The rangelands where CarbonSolve is targeting carbon projects are fire-prone systems** – i.e., they have evolved with fire as a naturally occurring disturbance process.
- **In general, decreasing the spatial and temporal occurrence of fire events along with decreasing their magnitude *without eliminating fire from fire prone savanna ecosystems* will increase the amount of carbon in both soil and woody carbon pools**.
- **However, the different characteristics of fire regimes have different impacts on each carbon pool.** While complex, there are strong "signals" from extensive research on each carbon pool that help clarify how each carbon pool will be affected.
- **The impact of fire on soil carbon is easier to understand than on woody carbon.** That is because of two primary factors.
  - o *Fire magnitude (severity and intensity) has less of an influence on below ground processes than above ground processes*. Fire only influences the surface/topsoil, and does not affect/damage deeper soils as they are insulated from fire affects and is where much carbon is stored.
  - o *Soil carbon in rangelands is predominantly influenced by grasses that are more resilient to fire than woody plants*. In addition, perennial grasses that generate the most soil carbon have deep root systems that are buffered from fire impacts.
- **Decreasing fire frequency increases soil carbon, particularly in areas that burn frequently**. This is because grasses and woody vegetation have time to grow between fire events, in addition they contribute organic material to the soil surface that can be converted into soil carbon via insect activity and microbial processes (decomposition).

- **Decreasing fire frequency and intensity increases woody carbon**. It is the damaging effects of fire on vegetation that is complex, because there are many different plant species and ranges of fire tolerance. In general, and for most woody plants in fire-prone ecosystems like savannas, non-destructive fire can promote growth and for some species fire is necessary for reproduction. Therefore, reducing the frequency and intensity of damaging fires increases growth and reproduction of woody plants, and therefore increases the carbon stored in the wood.
- **Interactions between soil and woody carbon change in response to fire are not as well studied, and therefore not as well understood**. In general, it is well documented that more carbon in the soil leads to greater moisture retention and nutrient cycling[7]. This, in turn, is better for vegetation. However, significant variability in fire regimes in relation to differing ecosystems, combined with the paucity of studies on both above and below ground carbon fluxes means there is scant evidence to explain the relationship between these two carbon pools under changing fire regimes in savannas. This is consistent with the lack of research on interactions across different types of disturbances mentioned earlier.

3. What evidence is there that if fire frequency/intensity is reduced, soil carbon will increase?

- **The most convincing evidence came from a recent global study that showed decreasing fire frequency in savannas results in an increase in soil carbon**, and conversely, an increase in fire frequency results in decreasing soil carbon[8]. These results were consistent globally, and in Africa specifically.
- **There are few studies that have investigated this relationship closely**. This is why the study mentioned above is so important. That is also why CarbonSolve has done some internal research on this in Miombo woodlands and has confirmed this pattern in Zambia[9], and that the pattern holds true for 16 projects in Africa across multiple countries that sent us their data (unpublished results).

4. How effective is shifting from late to early burning in changing soil carbon?

- **We are not aware of any studies that investigate how changing seasonality will change soil carbon.**
- **We are aware that changing seasonality from late to early burning can result in significant reductions in emissions of GHGs[10] in Australia**. However, they did not gather information on soil carbon and so it is not possible to answer this question with their data.
- **We do anticipate that less damaging fires from shifting fires earlier will increase woody carbon as described above**.

5. How can fire be controlled?

- **There are many ways to control fires** – best thought of in the context of "fire regimes" as described above (Q1).
- <u>**Fire size**</u> **can be reduced by various types of prescribed fires or extinguishing fire.** For example, prescribed fires that include **fire breaks** (i.e., cutting of vegetation, use of roads and areas that don't burn to remove fuel loads so that fires have nothing left to burn**)** **back burns** (i.e., lighting fires that

burn toward another fire and create a fire break in the process) **and fire suppression** (manually putting out fires with water from trucks or people with backpack sprayers and people with fire beaters). All of these activities stop the spread of a fire, and therefore reduce its size.

- **__Fire frequency__ can be reduced by fire prevention, fire suppression and reduction of fire size.** By preventing the spread of fires to areas that burn a lot, as well as putting out fires as soon as they start via fire breaks, back burns, and extinguishing fires, fire frequency can be reduced.
- **__Fire seasonality__ can be changed with prescribed fires.** By intentionally lighting fires in a different part of the fire season (usually earlier in the fire season but not always), it is possible to shift seasonality.
- **__Fire intensity__ can be reduced by changing the timing of fires** (e.g., fires at night, fires that burn into wind, and fires that burn under high humidity conditions burn cooler).
- **__Fire severity__ can be reduced by keeping fuel loads low via prescribed burning**. For example, if an area builds up a lot of fuel (e.g., excessive amounts of dry, rank grass, dead branches, and downed trees) then fires can burn faster and hotter with higher flame heights that can do more damage.

6. What fire management practices would carbon projects adopt?

- **The most important fire management practice would be the judicious use of fire breaks**. Fire patterns over seasons and years are now possible to recreate via satellite imagery. Understanding where and how most fires start, and then constructing fire breaks to prevent their spread is the most reliable and tested fire management technique in Africa. Fire breaks in grasslands can be made with tractors and grass mowers and "brush hogs" that can reduce tall grass and short woody vegetation so that fires lose intensity when they reach them, and either burn out on their own or can be put out.
- **An important activity will be the early detection of fires and rapidly deploye fire suppression activities when possible.** Fire suppression would be first addressed with teams of trained firefighters equipped with waterbowser trucks, backpack sprayers, and fire beaters.
- **Prescribed fires will be used when necessary.** Only when conditions are optimal and prescribed fires are necessary will this technique be used. Mostly, prescribed fires would be considered under the lowest risk scenarios (e.g., at night, cool season, into wind, high humidity, low fuel loads).

7. How feasible are such practices? Can they be implemented at scale?

- **Our goal is to reduce fire frequency** in areas that currently (over the past 10 years) burn so frequently (i.e., every year or more) that the frequency can be realistically reduced (but not eliminated) to burning on average every other year or every third year. **In addition, we plan to reduce fire intensity** by reducing fuel loads and the timing of fires specifically for above ground woody carbon accrual.
- **There is ample evidence from landscape-scale projects working across entire protected areas in Africa that all these practices can be applied across the areas we identify as the priority locations within the protected area for fire management**. We have gathered evidence from the Grumeti Fund in Tanzania[11], Frankfurt Zoological Society in Zambia[12], and African Park in Central African Republic and the Democratic Republic of the Congo[13] that show it is possible to dramatically reduce fire frequency and intensity within protected areas in Africa.

- **Significant research in Northern Australia by the Savanna Burning program has shown that fires seasonality can be shifted via early burning programs**, and these have significantly reduced GHG emissions in savannas over many years and over large areas[10].

8. What would be the cost?

- We anticipate a relatively high **initial start up cost for the first three years of <$30 USD/ha** for the areas that are a priority for fire management for carbon benefits. This relatively high cost is due to the high cost of equipment, training, and remote locations. **The long-term maintenance costs are approximately a third of the startup costs (e.g., $7-10 USD/ha).**
- These costs include robust monitoring and evaluation programs necessary to ensure the projects can be adaptive to changing circumstances as the fire program matures over time (i.e., 40 years).

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