Management opportunities for enhancing terrestrial carbon dioxide sinks


Objectives

- This work seeks, in part, to estimate the amount of carbon being sequestered by natural processes at global, North American and national US scales.
- A review of current strategies for carbon management in both North American and US terrestrial ecosystems was performed and is presented.
- In addition, the potential for deliberate human actions to augment natural carbon sinks are identified, quantified and presented.

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- Globally, agriculture accounts for $5.6 \pm 0.5$ PgCO$_2$eq yr$^{-1}$, therefore, agricultural activities have a profound influence on the sequestration of C and the net fluxes of GHGs.
- The greatest potential for soil C sequestration associated with agriculture lies with no-till practices, which could, on average remove 1.22 metric tons of CO$_2$eq per hectare per year, totaling over 11 TgCO$_2$eq/year.
- Forestry management activities can potentially increase carbon sequestration in the US by 370 to 740 TgCO$_2$eq per year.
- Crops for use in energy production and biomaterials have come to the forefront of alternative energy discussions. There are issues associated with such crops, and those issues must be addressed, as well the substantial potential to sequester carbon with these methods.
- Several experimental techniques for enhancing soil C sequestration have been proposed and tested. Three of these methods are reviewed: biochar production, deep soil C sequestration and modification of plant characteristics via biotechnology. Each of these has potential usefulness, but all require further study.
Significance

• Addressing climate change will require terrestrial carbon management efforts as well as reduction in fossil-fuel emissions.

• About $\frac{1}{10}$th of the Earth’s land surface is covered by cropland, about $\frac{1}{4}$ consists of grasslands and savannas and about $\frac{1}{4}$ is covered by forest, each of which offers an opportunity to manage C sequestration. Therefore, the potential for mitigating increasing atmospheric CO$_2$ concentrations through the use of terrestrial biological carbon sequestration is substantial.

• No single terrestrial biological management practice will solve the CO$_2$ problem; however, various approaches have potential to reduce atmospheric GHG climate forcing and have considerable benefits beyond GHG management alone.

• Many C management practices have a dual effect, where added benefits are economically or socially desirable. For example, forest management to maximize C sequestration may increase biodiversity of the ecosystem.

• Some practices, such as reduced tillage, improved silviculture, and use of woody bioenergy crops are already being implemented, primarily because of their economic benefits and associated ecosystem services.

• Other strategies, such as the use of biochar and cellulosic bioenergy crops may also be useful, but require further evaluation to determine whether widespread implementation is warranted.

• Carbon sequestration using proven land-management techniques can make a substantial contribution to emissions mitigation in the upcoming decades.

• To mitigate emissions long-term, however, carbon management should go beyond the concept of the management of a ton of C alone (as in an engineering system), but also included consideration of C sequestration as an important part of terrestrial ecosystems.
Figure 1:
Soil coverage by crop residue in a long-term no-till field in central North Dakota. Crop residues reduce evaporative water loss and soil erosion potential, while increasing soil C and improving soil fertility and structure for plant growth.