DRAWDOWN GA

LAND SINKS

AFFORESTATION & SILVOPASTURE

COASTAL WETLANDS

TEMPERATE FOREST PROTECTION & MGMT

TEMPERATE FORESTS

OVERVIEW OF A HIGH-IMPACT DRAWDOWN SOLUTION

Restoring and protecting temperate-climate forests has many benefits including carbon sequestration from trees, soil and other vegetation.

TECHNOLOGY AND MARKET READINESS

Almost 60% of land in Georgia is comprised of naturally-recruited and planted temperate forests, and Georgia is the number one forestry state in the nation, so this is definitely a market-ready solution (Edwards et al. 2013). For example, about 150,000 acres are planted in Georgia with pine seedlings each year (GFC, 2019).

LOCAL EXPERIENCE AND DATA AVAILABILITY

With our large extent of temperate forests and the importance of forestry for the state's economy, we have abundant local experience and data availability on Georgia's temperate forests from universities; county, state and federal agencies; NGO's and businesses.

TECHNICALLY ACHIEVABLE POTENTIAL FOR INCREASED CO2 SEQUESTRATION

Almost 60% of land in Georgia is comprised of native and planted temperate forests, and Georgia is the number one forestry state in the nation. Georgia's forests offset approximately 8% of the state's CO2 emissions, and can sequester one to four tons of carbon per acre, per year (GFC, 2019). Based on Forest Inventory and Analysis (FIA) data, between 2007 and 2017 forests of Georgia accumulated an average of 27 Mt CO2 annually in living tree biomass above and below ground [1]. A preliminary estimate of annual carbon uptake in state soils is 3 Mt CO2 (Richter et al. 1999, Carey et al. 2016, Crowther et al. 2016, Machmuller et al. 2018). This brings the total estimated annual carbon sequestration of Georgia's forests to 30 Mt CO2.

An increase in this annual carbon sequestration by 1 Mt CO2 by 2030 could be achieved by expanding Georgia's forest acreage by 2.9%. To put this in perspective, a 15% increase of forest acreage would be achieved if Georgia's forests in 2030 covered the same acreage as it did in 1974.

COST COMPETITIVENESS

Almost 60% of the current State of Georgia is comprised of native and planted temperate forests so little cost would be associated with maintaining these forests and this solution relative to other solutions. For planted pines with management, the cost of aboveground carbon storage is about $11 per ton C. The cost for unmanaged forests is essentially $0 per ton C in Georgia (Fuller and Dwivedi, unpublished data).

BEYOND CARBON ATTRIBUTES

Positive environmental impacts from this solution include improved air quality from trees' natural ability to provide oxygen, as well as increasing wildlife habitats and biodiversity (Bonan, 2008). Estimates suggest that trees and forests removed 17.4 million tonnes (t) of U.S. air pollution in 2010 (Nowak, et al., 2014). Increased air quality greatly improves public health of communities in the surrounding areas, which was valued at $6.8 billion in annual health effects in 2010, avoiding over 850 deaths and 670,000 acute respiratory symptoms. Forests offer improved water quality through soil protection, reduced water runoff and evapotranspiration (Trabucco, et al., 2008).

Forests create jobs in the areas of forest protection and management, corresponding to the areas with the highest forest coverage, [2] but temperate forests may also need to be legally managed (Guariguata, et al., 2010). Another positive benefit is improved quality of life forests provide by offering recreational opportunities for people in the local community and/or tourists [3]. Since there is little to no cost for these recreational opportunities, this solution is highly accessible to low-income families.

A potential barrier is that the temperate forest land use may restrict rural land available for farming/food and could potentially lead to a reduction in timber-related jobs (Chazdon, 2008).

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AFFORESTATION

OVERVIEW OF A HIGH-IMPACT DRAWDOWN SOLUTION

Afforestation is the process of creating forests in places that are no longer forested. This could include planting trees on degraded agricultural or pasture lands and planting in urban areas. Forests sequester carbon in trees, soil, and other vegetation.

TECHNOLOGY AND MARKET READINESS

Planting trees on formerly forested lands that are now developed (urban, suburban) or used for agricultural pastures would benefit both the carbon sequestration potential and protect humans and livestock from intense summer heat via shade (Karl et al. 2009, Bastin et al. 2019). Georgia is the number one forestry state in the nation and has urban tree planting programs such as Trees Atlanta [1], so the Technical and Market Readiness benefits of Afforestation are present.

LOCAL EXPERIENCE AND DATA AVAILABILITY

Georgia is the top forestry state in the United States, and agriculture as a whole is the most important business in the state. We also have established tree planting programs in Atlanta and other cities, so we have much local experience, expertise, and data for afforestation. Afforestation data can be easily estimated using National Land Cover Database available free of cost to users (NLCD, 2016).

TECHNICALLY ACHIEVABLE POTENTIAL FOR INCREASED CO_2 SEQUESTRATION

Forests are the main natural terrestrial carbon sink on the planet (Crowther et al., 2016, Carey et al., 2016). According to the USDA (2016), 11.1% of the state of Georgia was in croplands in 2012 for a total of about 4.19 million acres. Conservatively, if 10% of Georgia's current croplands are afforested with mixed tree species, equivalent to 0.42 million acres, this would increase CO_2 uptake and storage in living tree biomass by 0.46 Mt CO_2 per year. However, if instead these lands were planted as loblolly pine (Pinus taeda) plantations, this CO_2 uptake rate in living biomass would increase to over 1.8 Mt CO_2 per year by 2030.

When CO_2 storage in soils is also considered, the CO_2 sequestration would increase further (see "Silvopasture" solution). For each Mixed Species versus Loblolly scenario, the estimated CO_2 sequestration refers to CO_2 stored in both trees and in soils. The mixed tree species scenario at a 10% crop+pasture planting level would sequester 5.3 Mt CO_2 in 2030. The Loblolly Pine scenario with a 10% crop+pasture planting level would sequester 7.8 Mt CO_2 in 2030. Also see the discussion of "Silvopasture" which overlaps with this solution's estimated carbon sequestration.

COST COMPETITIVENESS

Forestry is one of the state's biggest economic sectors. For planted pines with forestry management the cost of aboveground carbon storage is about $3.5 per ton of CO_2. The cost for unmanaged forests is essentially $0 per ton of CO_2 (Fuller and Dwivedi, unpublished data).

BEYOND CARBON ATTRIBUTES

Reforesting formerly forested lands would provide biodiversity conservation, jobs, and freshwater quality benefits.

Environmental benefits of afforestation include improved air quality through a reduction in particulate matter (Nowak, 2002). Afforestation provides habitats for wildlife further benefiting local ecosystems and may provide social-economic opportunities through timber production, and recreation, and tourism. Since these solutions are often concentrated in rural areas, the environmental and social benefits are often accessible to lower income groups, providing increased mental/physical health from outdoor recreational opportunities (Karjalainen, et al., 2009).

The rural land use available for farming may be reduced, but may be supplemented by farming tree products, which can lead to economic benefits for landowners, increasing sustainable income (Hardy, et al., 2018).

Afforestation also has the potential to cut farmer's costs by reducing the need for feed, fertilizer and herbicides, and can improve the fertility of soil with clay content. However, costs to establish and maintain the solution, for example increased water usage to plant trees, pruning, and root damage to infrastructure, should be considered. Additionally, trees can be a source of seasonal pollen allergies.
Afforestation is positively linked to infant health; increasing fresh plant-based food supply in food deserts lowers prematurity and low birth weight rates in these areas (Zhang, et al., 2018).

Economic barriers to implement and maintain afforestation may be an issue for low-income farmers (Current, et al., 1995). Shifting traditional farming routines is a potential issue for new solutions that are not typically custom for farmers, and therefore may not be easily adopted (Calle, et al. 2009). See also "Silvopasture."

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SILVOPASTURE

OVERVIEW OF A HIGH-IMPACT DRAWDOWN SOLUTION

Silvopasture is the practice of adding trees to pastureland. Silvopastures can sequester carbon in the trees and soil and help counteract the methane emissions associated with raising cattle on pasture lands.

TECHNOLOGY AND MARKET READINESS

Silvopasture is an ancient practice, integrating trees and pasture into a single system for raising livestock. It can help sequester carbon, reduce soil erosion, improve water quality by shading streams (Franzluebbers et al., 2000) and provide shade for livestock which improves animal health and productivity (Swift and Messers 1971, Clinton 2011, Baas et al. 2017, NRDC 2017, USDA n.d.). Shade-tolerant and semi-tolerant crops such as blueberries and blackberries can also be incorporated into Silvopastures. In combination with the "Afforestation" solution, Silvopasture is a technological and market ready solution.

LOCAL EXPERIENCE AND DATA AVAILABILITY

Georgia has limited experience and operational data at large scale to assess its potential. However, the state of Georgia has about 2.8 million acres of pastureland, which could be converted into silvopasture practices (USDA 2016, USDA-NASS). (Also, see "Afforestation.)"

TECHNICALLY ACHIEVABLE POTENTIAL FOR INCREASED CO2 SEQUESTRATION

The solution has the potential to sequester more carbon in the soil (Morgan et al. 2010). According to the USDS (2016) 7.3% of the state of Georgia was in pastures in 2012 for a total of about 2.8 million acres. Conservatively, we consider the option of planting trees in 10% of Georgia's current pastures. Two approaches are considered: (1) planting with mixed tree species (which is preferable for biodiversity and wildlife, but sequesters a bit less CO2) and (2) planting entirely as loblolly pine (Pinus taeda) (which sequesters more CO2 but could cost more if actively planted and managed, and is not as beneficial for biodiversity).

For each scenario the estimated CO2 sequestration refers to CO2 stored in both trees and in soils. The mixed tree species scenario at a 10% crop+pasture planting level would annually sequester 5.3 Mt CO2 in 2030. The Loblolly Pine scenario with a 10% crop+pasture planting level would annually sequester 7.8 Mt CO2 in 2030. Also see the discussion of "Afforestation" which overlaps with this solution's estimated carbon sequestration.

COST COMPETITIVENESS

Cost depends on the adoption rate of farmers in Georgia and the potential incentives provided to the farmers. Economic analysis suggests that silvopasture systems are more profitable over time than monoculture system (Stainback and Alavalapati, 2004). Also see "Afforestation."

BEYOND CARBON ATTRIBUTES

Reforesting formerly forested lands would provide biodiversity conservation, jobs, and freshwater quality benefits.

Environmental benefits of afforestation include improved air quality through a reduction in particulate matter (Nowak, 2002). Afforestation provides habitats for wildlife further benefiting local ecosystems and may provide social-economic opportunities through timber production, and recreation, and tourism. Since these solutions are often concentrated in rural areas, the environmental and social benefits are often accessible to lower income groups, providing increased mental/physical health from outdoor recreational opportunities (Karjalainen, et al., 2009).

The rural land use available for farming may be reduced, but may be supplemented by farming tree products, which can lead to economic benefits for landowners, increasing sustainable income (Hardy, et al., 2018).

Afforestation also has the potential to cut farmer's costs by reducing the need for feed, fertilizer and herbicides, and can improve the fertility of soil with clay content. However, costs to establish and maintain the solution, for example increased water usage to plant trees, pruning, and root damage to infrastructure, should be considered. Additionally, trees can be a source of seasonal pollen allergies.
Afforestation is positively linked to infant health; increasing fresh plant-based food supply in food deserts lowers prematurity and low birth weight rates in these areas (Zhang, et al., 2018).

Economic barriers to implement and maintain afforestation may be an issue for low-income farmers (Current, et al., 1995). Shifting traditional farming routines is a potential issue for new solutions that are not typically custom for farmers, and therefore may not be easily adopted (Calle, et al. 2009). See also "Silvopasture."

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COASTAL WETLANDS

OVERVIEW OF A HIGH-IMPACT DRAWDOWN SOLUTION

Coastal wetlands, including mangroves, seagrasses, tidal salt marshes and freshwater marshes, are powerful carbon sinks. These ecosystems sequester carbon in plants and soils.

TECHNOLOGY AND MARKET READINESS

The state of Georgia has ~100 miles of coast and the coastal wetlands. Further, with a few small exceptions these wetlands are owned by federal, state and conservation agencies (the exceptions being Jekyll Island, Tybee Island, and St. Simons). Georgia's Department of Natural Resources reports 420,324 acres of tidal salt and freshwater marshes in Georgia comprising the largest number of tidal wetlands of any state in the U.S. Atlantic seaboard (Seabrook 2006, Edwards et al. 2013) [1]. Further, Georgia's tidal marshes are among the most productive ecosystems in the world on a per unit area basis (NASEM 2019, EPA 2019, Edwards et al. 2013, Schlesinger and Bernhardt 2013, Ouyang and Lee, 2014, Schubauer and Hopkinson 1984, E. Odum 1961). Thus, maintaining Georgia's Coastal Wetlands is an important Drawdown Georgia solution.

LOCAL EXPERIENCE AND DATA AVAILABILITY

We have many local coastal wetland experts at universities, state and federal agencies, and NGO's and much data from Georgia.

TECHNICALLY ACHIEVABLE POTENTIAL FOR INCREASED CO_2 SEQUESTRATION

Globally tidal marshes sequester 7.98 t CO_2 ha^{-1} each year (NASEM 2019, EPA 2019). Georgia has 420,374 acres of tidal marshes1 so has an annual CO_2 sequestration rate of 1.4 Mt CO_2 mainly in sediments. In comparison, estimates for the entire continental U.S. coastal wetlands including the mangrove forests of Florida is 8 Mt CO_2e per year (NASEM 2019, EPA 2019).

COST COMPETITIVENESS

The vast majority of Georgia's coastal wetlands are already protected by government and conservation agencies making this solution very cost competitive in terms of initial land acquisition. However, sea level rise will make the management and conservation of coastal wetlands more expensive due to management efforts such as acquiring buffers for future marsh migration.

BEYOND CARBON ATTRIBUTES

Coastal wetlands, including salt marshes in estuaries and freshwater wetlands, provide positive social-economic benefits by acting as the first line of defense from storm surges and floods. A study on flood damage reduction in the Northeastern United States found that wetlands avoided $625 million in flood damage during Hurricane Sandy, and on average, coastal wetlands reduced annual flood losses by 16% (Narayan, et al., 2017). Coastal wetlands enhance water quality and provide crucial habitat, nurseries, and shelter for fish, migratory birds, and other wildlife. Over 35% of endangered species live only in wetlands, with additional species requiring wetland habitats to reproduce (Kusler, 1983).

Other benefits include the potential increase in fishery and coastal tourism. Since over one third of all U.S. adults participate in wetland tourism activities, wetlands are a huge economic opportunity for their respective communities [3].

These factors can lead to increased quality of life, jobs, and safety for the residents living within coastal communities. A potential beyond carbon concern relates to development and construction firms' inability to develop coastal floodplain areas.

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