Chatham County Climate Change Advisory Committee

Forestlands and Farmlands Subcommittee Recommendations and Report

June 1, 2017

Overview

Farmers, woodland owners, Chatham County and its municipalities can play two important roles in responding to climate change: They can increase carbon sequestration – a process whereby forests and farmlands extract carbon dioxide from the atmosphere. They can also decrease agricultural and other greenhouse gas (GHG) emissions: carbon dioxide (CO2), nitrous oxide (N2O) and methane (CH4). Chatham County and its municipalities can promote these processes by undertaking three basic actions highlighted below. These actions should be undertaken soon and continued indefinitely.

First, local governments can assist landowners in the preparation of individualized climate adaptation and mitigation plans that increase carbon sequestration and decrease GHG emissions. A collaborative effort involving our local governments, area universities and state/federal agencies should be able to acquire such financial resources as may be necessary. As highlighted in this report, multiple mitigation and adaptation options are available. One option is the use of Forest Stewardship concepts in forestland management. Of course, the option best suited for any one landowner will vary based on individual economic needs and land characteristics. Accordingly, the general adaptation and mitigation actions suggested in this document will need to be tailored to each individual situation.

Secondly, our four local governments can (a) prepare and implement complementary land use plans, zoning ordinances and development ordinances that promote carbon sequestration. They can also promote carbon sequestration by (b) developing and implementing mitigation and adaptation plans for properties they own or control. These plans could serve as models for private landowners. Resources have been created to help

guide this planning process, as well as to guide local and state governments in their efforts to support expansion of adaptation. An excellent example is the detailed report of the North Carolina Agriculture and Forestry Adaptation Work Group (NC ADAPT), available here: http://sfldialogue.net/files/NC_STRAT_forestry_adaptive_management_jan17.pdf

Lastly, a key element in all of these efforts will be climate change education directed at landowners and at all Chatham County residents. Educational efforts could include (a) information provided by the Climate Change Committee through programs and publications, (b) individual consultation through such organizations as the Cooperative Extension Service and (c) meetings of farmers and woodland owners through established groups and otherwise.

Basic information concerning actions farmers, woodland owners and our local governments can take to mitigate and adapt to climate change is outlined in this document, provided in a question and answer format. The process of developing site specific actions for individual landowners may benefit from the participation of public and privately sponsored professionals and resources.

How do forestlands and farmlands affect climate change?

Carbon dioxide (CO_2) is taken up by forests, grasses and agricultural crops. The carbon is stored/sequestered in plant matter and the soil (Romm, p85). Forests and woodlands are especially important. Worldwide they sequester approximately 28% of all global fossil fuel emissions – about the same as oceans. In the United States forests offset approximately 16% of U.S. fossil fuel emissions.

Although methane (CH_4) has an average atmospheric lifespan of only 12 years, over a 20-year period it is 86 times more heat trapping than carbon dioxide (Romm, p202). Agricultural methane is produced by ruminant livestock and manure management. Globally, agriculture is a leading source of human induced methane emissions (Romm, p247).

Agricultural nitrous oxide (N_2O) emissions stem primarily from the use of nitrogen-based fertilizers. https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data. N_2O has a lifespan of 114

years and a warming impact 310 times that of CO2 over a 100-year time frame. http://nationalaglawcenter.org/wp-content/uploads/assets/crs/R40874.pdf at p. 2. Globally, about 40% of N2O emissions come from human activities. In the United States approximately 73% of human induced nitrous oxide emissions in 2009 were due to agricultural activities – especially the use of artificial nitrogen fertilizers. https://www.eia.gov/environment/emissions/ghg_report/ghg_nitrous.cfm. at p. 1. While forestry and agriculture in Chatham County are expected to emit minimal amounts of methane and nitrous oxide, it would be useful for baseline data to be developed. Attempts should be made to reduce even such low levels of emissions, wherever economically feasible.

Forestlands, woodlands and farmlands therefore play an important role in impacting climate change. As noted earlier, there are two areas where landowners can focus their efforts to have a positive impact on climate and also improve the future outlook of their farming business in this changing climate: mitigation and adaptation.

Mitigation Options for Private Forestland and Farmland Owners

Mitigation consists of efforts to reduce global warming through (1) reductions in GHG emissions and (2) increases in carbon sequestration.

Reduce Emissions of Methane and Nitrous Oxide

Reducing CH4 and N2O emissions can be fostered by reducing the use of artificial nitrogen fertilizers and changing manure management practices.

CH4 emissions can be reduced through multiple activities including the following:

- Applying manure to soil as soon as possible consistently with other recommendations below;
- Avoiding manure application on extremely wet soils;
- Avoiding manure application when heavy rain is predicted;
- Increasing the digestibility of livestock feed by chopping, grinding or pelleting feed;
- Feeding additives such as ionophores that act to inhibit methane production;
- Structuring manure storing tanks or lagoons so as to allow capture of methane through anaerobic digestion followed by aerobic composting for nutrient recovery;
- Effective composting of manure, optimally, after anaerobic digestion.

N2O emissions can be reduced through multiple activities including the following:

- Applying manure shortly before crop growth to allow maximum use of nitrogen;
- Avoid applying manure in the late fall and winter;
- Avoid applying manure when the weather is hot and windy, or before a storm because these conditions can increase nitrogen oxide emissions;
- Spreading manure evenly around fields and pastures;
- Storing manure in below ground facilities;
- Implementing soil and water management practices such as improving drainage;
- Effective composting of manure, optimally, after anaerobic digestion.

Effective methane and nitrous oxide mitigation planning may require professional input that local governments and universities may be able to provide as assistance to local farming operations.

Increase Carbon Sequestration

Four approaches can promote carbon sequestration:

1. Afforestation - converting non-forested lands to forests;
2. Reforestation - replanting trees (quickly) on lands that once were forested;
3. Forest Preservation - keeping forests on forested lands, i.e., avoid clearcutting; and
4. Forest Management - minimizing damage to plants and mycorrhizal fungi on the forest floor, planting trees that rapidly capture carbon and increasing the period of time between tree harvests.

Of special importance is the planting of native broadleaf trees rather than loblolly pine. This is especially true where site-specific characteristics – such as soil – make this an appropriate silviculture choice. The reason for this recommendation is that broadleaf species absorb more carbon dioxide and retain significantly more soil moisture than do pine plantations. In an era of climate change, retaining soil moisture is increasingly important.

Creating and implementing effective carbon sequestration plans and practices must contend with multiple uncertainties. These include - but are not limited to - (a) forest disruptions such as fire, drought and insect infestations, (b) the carbon capture potential of different types of trees, (c) soil disturbances that affect

understory plants and mycorrhizal fungi, (d) nitrogen depositions, (e) atmospheric CO2 levels, (f) temperature levels, and (g) the economic needs of the landowner. Given these and other uncertainties (such as the market demand for wood) effective mitigation planning for carbon sequestration in forests may also require professional input that local governments and universities may be able to provide. Initially, mitigation planning should include education and voluntary efforts to help landowners reduce global warming and adapt to our new, harsher climate.

Adaptation Options for Private Forestland and Farmland Owners

Adaptation involves changing forest and farm management techniques so as to protect against with the negative economic and environmental impacts of climate change. For example, adaptation planning can minimize flood damages by encouraging private landowners to plan for the more extreme rainfall events that will result from climate change. In this case, adaptation planning would encourage landowners to locate structures on higher ground that can accommodate a 50- or 100-year storm rather than the typical 10 year storm.

According to research published by the National Academy of Sciences of the United States in 2007 entitled "Adapting Agriculture to Climate Change", the benefits of adaptation in temperate areas will be more effective when temperature increases are under 2° C and when rainfall amounts increase rather than decrease. In these cases a wide variety of adaptation alternatives exist for crop, livestock and tree farming. A few of these include:

1. Changing species to those better adapted to the changing climate;
2. Changing the timing and location of crops;
3. Increasing the use of methods that enhance soil microbiology and reduce the need for synthetic fertilizers;
4. Intensive management of pasture rotations (also known as holistic management of grazing animals);
5. Increasing the use of integrated pest and pathogen management;
6. Changing landscape management practices so as to minimize fire and insect damage to forests, including controlled burns;
7. Increasing the use of soil carbon sequestering and nitrogen fixing cover crops. Again, effective adaptation planning may require professional input from Cooperative Extension or similar sources.

Effective adaptation planning also can promote climate change mitigation efforts. For example, farming practices that sequester carbon dioxide in the soil will increase the moisture holding capacity of the soil and allow crops to better adapt to summer heat stress and drought with less energy-intensive irrigation. These same adaptation techniques also can help mitigate future global warming by extracting carbon dioxide from the atmosphere and putting it in safe storage in the soil.

How can local governments help forest and farm landowners voluntarily minimize their contributions to climate change?

Local governments can (a) help educate landowners about climate change realities, (b) assist in preparing mitigation and adaptation plans, and (c) provide incentives for plan implementations.

Avoiding catastrophic climate change will require local, national and international efforts. At the local level, governments could (1) sponsor climate change research and education, (2) help forest and farm landowners create mitigation and adaptation plans and (3) help landowners create plans to minimize climate change by increasing carbon sequestration and reducing CO2, CH4 and N20 emissions.

In terms of research and educational efforts, local governments could convene meetings of stakeholders to map actions local governments could take to encourage continuation of forests and farms as working land instead of being converted to suburban and urban developments. Such actions could include (a) promoting local markets for forest products by promoting more wood in local government buildings; (b) providing financial incentives for existing industries to use sustainably sourced biomass for energy instead of natural gas and other fossil fuels; and (c) boosting markets for compost produced within the County.

Increasingly, resource documents are available to help guide the process of planning for adaptation. Such resources can also guide local and state governments in their efforts to support expansion of adaptation. An excellent example is the detailed report of the North Carolina Agriculture and Forestry Adaptation Work Group (NC ADAPT), available here:

http://sfldialogue.net/files/NC_STRAT_forestry_adaptive_management_jan17.pdf

Another fine example is the 2012 report called "CLIMATE READY NORTH CAROLINA: Building a Resilient Future," by the N.C. Interagency Leadership Team (ILT).
http://www.climatechange.nc.gov/Climate_Ready_North_Carolina_Building_a_Resilient_Future.pdf

---

What other efforts can local governments take to promote increased carbon sequestration?

Local governments can use various ordinances to increase carbon sequestration and adaptation. These include:

1. Requiring new Best Management Practices (BMPs) in permits for land development activities. BMP's can require, for example:
    a. using the best site-specific science on soil carbon sequestration, identification of premium carbon storage lands and establishing higher development standards for these lands;
    b. delayed or phased timber harvests;
    c. policies that incentivize forest continuity;
    d. reforestation on lands that will be left treeless for extended periods of time; and
    e. wider, forested stream management zones (including ephemeral streams) to guard against more intense and more severe rainfall events.
2. Local governments also can require development and construction bonds that promote use of climate sensitive forest management practices.
3. Local governments also can create land use plans and zoning ordinances that maximize continuation of existing forestlands and farmlands as working lands rather than other developed uses.
4. To ensure adequate enforcement of local ordinances, local governments may need to hire trained zoning enforcement officers.

5. Increasing carbon sequestration also can include public lands such as highway corridors, parks and school properties. Here grassed areas should be minimized and, to the maximum extent possible, broadleaf trees should be planted (in accord with soil and site characteristics).
6. As global warming becomes more intense, local governments in Chatham County could be prepared to enact such policy measures as are allowed by the State of North Carolina.
    a. These might include providing greater incentives under “present use” tax designation to forestland owners who undertake carbon sequestration and mitigation efforts.
    b. Funds for purchase of development rights and conservation easements or similar mechanism for soil carbon sequestration.
    c. These incentives could require the development of forest management plans utilizing “Forest Stewardship” concepts embodied in the voluntary NC Forest Stewardship Program. These concepts include:
        i. pursuing management methods that increase carbon storage and climate resiliency;
        ii. protecting soil and water resources;
        iii. utilizing adaptive management strategies that enhance biological diversity;
        iv. protecting wildlife; and
        v. enhancing recreational options.

How should local governments structure climate change efforts?

A cooperative approach should be taken to include complementary efforts by the four local governments in Chatham county concerning:

- Land use plans,
- Subdivision ordinances,
- Zoning regulations,
- Tree protection ordinances,
- Financial incentives and/or disincentives for landowners.
- Federal and state programs, such as the U.S. Department of Agriculture program entitled “Building Blocks for Climate Smart Agriculture and Forestry.”

- Resources available through the North Carolina Cooperative Extension Service, including the Voluntary Agricultural District Program.
- Resources available through the USDA Natural Resources Conservation Service, including local Soil and Water Conservation Districts.
- Assistance with research and educational efforts from area universities could be solicited.
- Dedicated staff should be funded at the County Cooperative Extension level to support landowners, foresters, and farmers in their efforts to learn the best science on adaptation and mitigation.

What challenges will local governments face?

Local governments can take meaningful actions to promote climate change mitigation and adaptation efforts even in the face of multiple challenges. However, early recognition of likely challenges often can help avoid program failures. These challenges include:

- Uncertainties as to the speed and severity of climate change;
- Uncertainties concerning the speed and severity of forest species collapse;
- Limited financial and staff resources;
- Inadequate state authorizations;
- Inadequate political support;
- Inadequate carbon sequestration and agricultural emissions baseline information;
- Inadequate measurement technologies.

Overcoming these challenges will require local governments to initiate concerted efforts to acquire money, staff, legal authorizations, political support, and baseline data.

Summary

Unfortunately, climate science cannot provide accurate climate forecasts for small areas – such as Chatham County. As a result, some uncertainty exists concerning our immediate future climate. This makes mitigation and adaptation planning difficult, although necessary. Nevertheless, the 2014 National Climate Assessment states over the coming decades the Southeastern United States can expect:

1. Significant increases in the number of hot days 95°F or above
2. Decreases in freezing events
3. Average temperature increases in the range of 4°F to 8°F
4. Drier conditions in the far southwest of the region
5. Wetter conditions in the far northeast of the region with precipitation generally decreasing across the entire Southeast
6. Fewer but stronger tropical storms.

North Carolina's State Climatologist, Dr. Ryan Boyles, has said the evidence suggests our state will likely experience:

1. Earlier onset of spring
2. Longer summers (25 to 30 days longer)
3. More heat and moisture stress for crops
4. Annually 30+/- fewer days per year of temperatures below 32 degrees Fahrenheit
5. Heavier, but less frequent rainfalls
6. More intense hurricanes involving greater precipitation and wind speed

How soon these climate conditions will occur depends on how fast global warming proceeds. If climate change proceeds as it has over the past two decades and average global temperatures increase 4° C by 2060 (as forecasted by the World Bank), then these conditions could occur by midcentury. If climate change is curtailed, these conditions could be delayed until the end of the century or perhaps stopped altogether. To the extent climate change cannot be slowed or stopped, mitigation and adaptation strategies such as those highlighted above will be necessary to support our agriculture community.

Definitions

Agriculture: Agriculture refers to the management of contiguous rural and urban pastures and fields in Chatham County of two acres and more in single or multiple parcels and in single or multiple ownership with management focusing on methods whereby owners can (a) adapt to climate change, (b) maximize carbon sequestration and (c) minimize greenhouse gas emissions.

Carbon Sequestration: terrestrial carbon sequestration involves the collection and storage of carbon dioxide by plants and the storage of carbon in soil.

Climate: Climate refers to the average weather over at least 30 years.

Climate Change: Climate change refers to … "variations in average weather conditions that persist over multiple decades or longer that encompass increases and decreases in temperature, shifts in precipitation, and changing risk of certain types of severe weather events" (Department of Defense Dictionary of Military and Associated Terms). Climate change is the result of global warming.

Climate Change Mitigation: Climate Change mitigation refers to efforts designed to reduce future global warming through increases in carbon sequestration and reductions in greenhouse gas emissions.

Climate Change Adaptation: Climate change adaptation means anticipating the adverse effects of climate change and taking appropriate actions to prevent or minimize the damage they can cause. Adaptation measures provide direct benefits to the landowner, farmer, or forester, such as reducing vulnerability to drought by increasing soil carbon, which also increases moisture retention.

Cover Crops: Cover crops refer to plants grown primarily to suppress weeds, manage soil erosion, maintain and improve soil fertility, control diseases and pests and promote biodiversity. Typical summer cover crops include legumes, grasses, soybeans, peas, and beans. Winter legumes include field peas, crimson clover, hairy vetch, and subterranean clover.

Forestry: Forestry refers to the management of contiguous rural and urban woodlands in Chatham County of two acres and more in single or multiple parcels and in single or multiple ownership with management focusing on methods whereby owners can (a) adapt to climate change, (b) maximize carbon sequestration and (c) minimize greenhouse gas emissions. Forests may either be recognized by Chatham County as "tree farms" with "present value" taxation or may be residential or commercial woodlands that are not officially "tree farms".

Global Warming: Global warming refers to "increases in Earth's average surface temperature due to rising levels of greenhouse gases" (NASA) with surface temperatures referring to the temperatures of upper oceans, land, ice and lower atmosphere.

Preindustrial Times: While preindustrial refers to mid 1700's and earlier, surface temperatures are typically based on 1850 – 1900 data.

Soil carbon: The amount of carbon stored in the soil is a component of soil organic matter --- plant and animal materials in the soil that are in various stages of decay. Soil organic carbon is the basis of soil fertility. It releases nutrients for plant growth, promotes the structure, biological and physical health of soil, and is a buffer against harmful substances.

References

For additional educational resources please refer to the Climate Change Advisory Committee page on the Chatham County website **http://www.chathamnc.org/index.aspx?page=1900**

Alberta Agricultural and Forestry "Manure Management and Greenhouse Gases - Things You Need To Know" (December, 2015)

Bellassen, Valentin; Luyssaert, Sebastiaan. (February, 2014). "Carbon Sequestration: Managing Forests in Uncertain Times".

Climate Change and Agriculture in the United States: Effects and Adaptation, U.S. Dept. of Agriculture, 2013

Darling, S. B.; Sisterson, D.L; (2014). How To Change Minds About Our Changing Climate.

Gorte, R.W- Congressional Research Service. (August 2009). "Carbon Sequestration in Forests" United States Department of Agriculture, Economic Research Service (2014).

NC ADAPT (North Carolina Agriculture and Forestry Adaptation Work Group), “Keeping North Carolina’s Farms and Forests Vibrant and Resilient through Adaptive Management: Priorities and Recommendations for Advancing Adaptive Management on Forest Lands,” January 2017. http://sfldialogue.net/files/NC_STRAT_forestry_adaptive_management_jan17.pdf

N.C. Interagency Leadership Team (ILT), “CLIMATE READY NORTH CAROLINA: Building a Resilient Future,” 2012. http://www.climatechange.nc.gov/Climate_Ready_North_Carolina_Building_a_Resilient_Future.pdf

Romm, Joseph. Oxford University Press (2016).Climate Change: What Everyone Needs To Know

Ryan, M.G.; Birdsey, R.A.; Hines, S. J. (October 2012). “Forests and Carbon Storage”. U.S. Department of Agriculture Forest Service, Climate Change Resource Center

S. Mark Howden, Jean-François Soussana, Francesco N. Tubiello, Netra Chhetri, Michael Dunlop, and Holger Meinke (August, 2007). “Adapting agriculture to climate change”. Proceedings of the National Academy of Sciences of the USA.

U.S. Dept. of Agriculture, Economic Research Service. (2016) “Agriculture and Climate Change”

U.S. EPA (2015) “Sources of Greenhouse Gas Emissions”