FOREST LANDOWNER RESOURCES FOR HURRICANE AND SOIL SALINIZATION PREPARATION AND RECOVERY IN THE SOUTHEASTERN UNITED STATES

Nancy Gibson, Steven McNulty, Michael Gavazzi, Chris Miller, and Elijah Worley

EXTENDED ABSTRACT

Hurricanes cause billions of dollars in damage each year, and the risk from hurricanes is projected to increase. Hurricane Michael (2018) and Laura (2020) are prominent, recent examples of storms that reached far inland while maintaining a category 4 and category 3 status. Hurricanes negatively impact forests through wind damage, storm surge flooding, causing reduced tree growth, mortality, and carbon loss. Storm surge can cause soil salinization when saltwater inundates coastal stands and infiltrates the soil. Sea-level rise associated with climate change also contributes to soil salinization in coastal areas through saltwater intrusion and rising ground-water levels. Forest yield decreases as soil salinity increases. Soil salinity is often measured as electrical conductivity (EC), and EC levels of $8 < 16$ dS m^{-1} render forest stands economically inviable. Foresters need management information to address these threats. Unfortunately, this information is hard to find or inconsistent across localities. Therefore, the U.S. Department of Agriculture Southeast Climate Hub developed hurricane and salinization guides to help producers prepare for, recover from, and adapt to these threats.

The Pine Forest Landowner Hurricane Preparedness and Recovery guide provides State-specific recommendations to build resilience and speed recovery from hurricanes. The guide covers planning phases such as the initial site location and operation building, annual maintenance and recordkeeping, and preparation for when a hurricane is imminent. The guide also includes steps for bringing the site back into production after a hurricane. The guide has four main sections: (1) the *Building a Resilient Operation* section outlines actions that producers can put in place to increase their resilience to hurricanes, (2) the *Long-Term Operation Maintenance* section lists specific pre-hurricane actions and periodic checks annually (before hurricane season) and monthly (during hurricane season), (3) the *Short-Term Preparedness* section lists specific actions to be done in the week before a hurricane arrives, and (4) the *Post-Hurricane Recovery* section outlines activities that producers can take to minimize losses following a hurricane. This section begins with safety-oriented actions immediately following a hurricane and continues with ongoing actions (e.g., post-hurricane inventory, recovery assistance programs) that can be taken in the following week and month.

Author Information: Nancy Gibson, Environmental Technician, U.S. Department of Agriculture, Southeast Regional Climate Hub, Research Triangle Park, NC 27709; Steven McNulty, Director, U.S. Department of Agriculture, Southeast Regional Climate Hub, Research Triangle Park, NC 27709; Michael Gavazzi, Coordinator, U.S. Department of Agriculture, Southeast Regional Climate Hub, Research Triangle Park, NC 27709; Chris Miller, Manager/Plant Specialist, U.S. Department of Agriculture, National Resources Conservation Service, Cape May Court House, NJ 08210; and Elijah Worley, Environmental Technician, U.S. Department of Agriculture, Southeast Regional Climate Hub, Research Triangle Park, NC 27709.

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In the Southeastern United States, soil salinization can be associated with hurricane-caused storm surge in the short term and with sea-level rise in the long term. Both hurricane and sea-level rise impacts are more significant concerns due to climate change. Salinization reduces the productivity of working lands and can prevent crops from growing. The salinization guide describes the impacts of soil saltwater intrusion and includes adaptation measures to maintain productivity in working lands. The first two chapters of the salinization guide describe the background information and assessment and minimization of salinity risk. These chapters include details concerning salinization processes, testing soil for salinity levels, and other descriptive information. The salinization guide frames soil salinization as stages, ranging from low (Stage Zero) to high (Stage Five) salinity impacts. Stage Zero is non-impacted land, and Stage Five is the point where sea-level rise has converted the land to chronic surface water. Each stage in this guide is assigned a range of EC values (e.g., Stage Zero: $0 < 2$ dS m^{-1}), and they increase as the stages progress (Stage Five: EC = >25 dS m^{-1}). The productivity of working lands decreases as soil salinity increases. The guide includes a description of each stage and productivity limitations to expect, along with mitigation and adaptation measures appropriate for the given stage.

Baseline site characteristics, such as productivity, are established at Stage Zero. Forest productivity is not impacted by salinity at this stage. However, the soil may be at risk of salinization due to proximity to a saltwater source. Stage One soils have low salinity, and forest stands are likely to recover from a single salinity event. Some seedling growth may be unaffected at these low levels of salinity. Mitigation efforts are only possible in Stage One, and conservation practices standards can be used for adaptation. Saltwater intrusion is expected to impact a growing extent in the Southeast. Eventually, salinization events will become a re-occurring issue.

Stage Two involves moderate salinity levels ($4 < 8$ dS m^{-1}) as salinization events occur at a faster rate than soil recovery. Forests may begin to show signs of salinity stress but can still be economically profitable. Site recovery depends on local hydrology and elevation. However, sea-level rise will continue to bring saltwater inland, leading to chronic salinization. Stage Three is characterized by chronic salinity and makes commercial forestry no longer a viable option. In Stage Three, trees exhibit a severe decrease in overall vigor, increased insect problems, sparse crown, inferior growth, increased mortality, short needle length in pines, small foliage in hardwoods, and increased overall appearance of poor health. Forestry operations in these areas are unlikely to be successful.

Chronic salinity can be identified in forests by encroaching salt-tolerant species, such as wax myrtle (*Morella cerifera*). The land can be left to transition naturally into saltmarsh, converted to a conservation easement, or cultivated with alternative salt-tolerant crops. Alternative crops such as salt meadow cordgrass (*Spartina patens)*, seashore mallow (*Kosteletzkya virginica*), switchgrass (*Panicum virgatum*), coastal panicgrass (*Panicum amarulum*), prairie cordgrass (*Spartina pectinata*), eastern gamagrass (*Tripsacum dactyloides*) can be planted in entire fields. Forests can survive at Stage Four, though their productivity will be very low. Tree mortality will lead to salt-tolerant vegetation such as cattail (*Typha* sp.), common reed (*Phragmites australis*), and sawgrass (*Cladium* sp.) that move into the open spaces left by the dead trees. Freshwater tree seedlings are unlikely to grow in a more saline environment. The saltmarsh described in Stage Five has environmental benefits such as carbon sequestration, shoreline stabilization, biodiversity, improvement of water quality through filtration of contaminants and sediments, reduction of flooding impacts, waterfowl, wildlife habitat, inland protection, hunting leases, and recreational value.

This presentation will provide an overview of both the hurricane and salinization guides. Additionally, the presentation will discuss where additional information on these topics can be found online.