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Soil Subsidence in the Everglades Agricultural Area

By: Alan L. Wright, Assistant Professor and George H. Snyder, Distinguished Professor, Emeritus
Everglades Research and Education Center, Soil & Water Science Department

Introduction

This document describes the soils in the Everglades Agricultural Area (EAA), an agricultural region in south Florida south of Lake Okeechobee growing primarily sugarcane and winter vegetables, and how the soils are changing with time. The objective is to describe soil loss in the EAA since this region was converted from wetlands to agricultural use, and to illustrate how these changes affect future sustainability.

The organic soils (Histosols) of the EAA formed over a period of several thousand years when organic matter production exceeded decomposition in the flooded sawgrass prairies that flourished in the area south of Lake Okeechobee. Since the onset of drainage of the EAA soils in the early 1900s for crop production, organic matter decomposition has exceeded accretion, resulting in a loss of soil and lowering of the surface elevation, a process referred to as subsidence. These Histosols are underlain by hard limestone bedrock, making subsidence all the more important since cultivation of the bedrock and water management would be difficult.

These Histosols formed because the land was flooded for much of the year, resulting in insufficient oxygen in the soil to maintain active populations of aerobic microorganisms that decompose organic matter. Oxygen penetration into the soil increases upon drainage, stimulating the activity of aerobic microorganisms. These microorganisms then decompose the soil organic matter at a much higher rate compared to the anaerobic microorganisms that dominate in flooded soil. As such, microbial activity as affected by drainage is considered the main factor influencing subsidence.
However, other factors also influence soil subsidence, including a loss of buoyancy following drainage, shrinkage and compaction caused by vehicular traffic, and soil loss by wind erosion and burning. It is likely that all of these factors have been partly responsible for subsidence in the EAA.

**Soil Subsidence**

Subsidence was observed as soon as the Everglades were drained in the early 1900s to remove water from soil to better support crop production. In 1924, a graduated concrete post was driven to the underlying bedrock at the University of Florida/IFAS Everglades Research and Education Center (EREC) near Belle Glade. The soil surface was level with the top of the post, which is 9 feet in length (Figure 1). During a 43-year period from 1924 to 1967, there was a 48 inch decline in soil depth at the subsidence post, resulting in a subsidence rate of 1.12 inches/year. As of 2009, the soil depth at the site was 37 inches. From 1967 to 2009, the elevation reduction was 71 inches, for an average subsidence rate of 0.55 inches/year. At this site, it is apparent that the soil subsidence rate has not remained constant through time, and in fact has decreased by 50% from 1924-1967 to 1968-2009.

![Figure 1. Decreases in soil depth since 1924 can be observed using the EREC subsidence post near Belle Glade, FL.](image)

The rate of subsidence throughout the EAA has been investigated and documented in several other ways. The subsidence rate estimate at the EREC subsidence post coincides favorably to estimates obtained from transect lines monitored across the EAA (Shih et al., 1998). Starting in 1913, and further augmented in the 1930s, a series of transects (termed subsidence lines) were established in which the surface elevation relative to mean sea level was measured at 25 to 50-foot intervals for a distance of several thousand feet every 5 to 20 years. Two east-west elevation transects were made in 1912, and a much more detailed measurement of surface elevation was made throughout the entire Everglades in 1939-1940.

In the 1930s, a study was conducted at EREC to relate the rate of subsidence to the depth to water table (Neller, 1944). Based on all of these studies, Stephens and Johnson (1951)
concluded that the subsidence rate would be one foot per decade assuming that the water table is maintained at an 18-24 inch depth. The resulting subsidence rate was calculated to be 1.2 inches/year, and this estimate was later substantiated by Shih et al., 1978 by monitoring the transect lines. Shih et al. (1998) measured surface elevation along the subsidence lines following a 19-year lapse in measurement, and concluded that the subsidence rate during this period averaged 0.57 inches/year. This rate was significantly lower than the 1.2 inches/year calculated by Stephens and Johnson (1951), and Shih et al. (1998) speculated that maintenance of higher water tables after 1978 was one of the major reasons for the observed reduction in the subsidence rate.

It thus appears that the subsidence rate has shown a declining trend through time. There are several potential mechanisms that can explain this decline, including increased mineral content in soil (Figure 2), humification, and water management (maintenance of higher water tables).

Figure 2. Increase in mineral content of shallow Histosols.

One argument for a decrease in subsidence is that mineral matter within the organic soil profile has become a major component of the soil matrix. As the organic matter is decomposed, the mineral content, such as calcium carbonate, sand, or clay, does not change and in fact its proportion to the total soil increases as subsidence continues.

As Histosols decompose, the easily degradable components are lost first, but the more resistant components persist longer, leading to decreases in the subsidence rate. The organic soils should become less easily oxidized with time as they become more humified and as the organic particles more resistant to decomposition accumulate. In addition to accumulation of
mineral matter, such a theory could predict or account for a reduced subsidence rate as soils become very thin over bedrock.

A major factor influencing the decline in the subsidence rate through time has been improved water management. It has been well documented that the subsidence rate is closely aligned with water table depth, as organic matter decomposition is impaired by flooded conditions (Stephens and Johnson, 1951; Snyder et al., 1978). Implementation of best management practices (BMPs) in the mid 1990s has led to more water storage on EAA fields, which helps to retard organic matter decomposition and decrease the subsidence rate.

**Current Trends**

During the 1930s and 1940s, the vegetables that were the primary crops in the EAA required good water control and did not tolerate flooded or waterlogged soils. Widespread adoption of sugarcane in the early 1960s led to changes in crop and land management practices, which increased water storage in EAA fields since sugarcane is more tolerant of flooded conditions. Shih et al. (1982) also observed that temperature reduction in sugarcane fields decreased the subsidence rate by 16%. These two mechanisms suggest that widespread cultivation of sugarcane contributed to a decrease in the rate of soil subsidence in recent years. Growers have also modified field operations in response to shallower soils by tilling less deeply and making fewer passes over the fields, which minimizes soil disturbance. Thus, growers have contributed to the reduction of the soil subsidence rate through their management practices. Continuation of BMP implementation by growers, development of crop cultivars more tolerant of flooded conditions, reduced tillage, and potential adoption of green manure crop rotations, will likely further minimize subsidence in the future and increase the longevity of these soils for agricultural use.

**For more information:**


The Florida Ag Expo: A Recipe For Success

By: Crystal Snodgrass, Manatee County Vegetable Extension Agent, Jack Rechcigl, Professor and Center Director, Gulf Coast Research and Education Center and Alicia Whidden, Hillsborough County Vegetable Extension Agent

The UF/IFAS Gulf Coast Research and Education Center (GCREC) in Balm, Florida recently hosted its fourth annual Florida Ag Expo in partnership with Meister Media Publishing. Balm is located in south eastern Hillsborough County, FL and is a central location for many of the area’s surrounding agricultural operations. The area produces a variety of agricultural commodities, but two of the largest are strawberry and tomato crops with approximately 8,300 acres of strawberries in Hillsborough County and over 12,000 acres of tomatoes in Manatee County, although when it comes to production, county lines don’t get in the way. It only seems natural to have a meeting of growers and other industry leaders in this agricultural hot spot.

The Florida Ag Expo started as an idea from long-time tomato growers Tony DiMare and Jay Taylor. After attending an agricultural event in Culiacan, Mexico the growers decided that they would like to see a similar event in Florida, since one did not yet exist. The idea was presented to the GCREC Director, Jack Rechcigl, and then UF’s senior vice president, Jimmy Cheek. Five years later, on Oct 28, 2009, the fourth Florida Ag Expo was carried out and many say that it was the most successful yet. It was presented by UF/IFAS, The Florida Strawberry Growers Association, The Florida Fruit & Vegetable Association, and The Florida Tomato Committee. The Florida Ag Expo is one of a kind. It is a true partnership between UF/IFAS researchers, extension agents, growers, and industry representatives. It’s not your typical trade show or conference. It is unique in that it ties in multiple activities for all audiences including educational sessions, field tours and vendor booths.
The educational sessions are presented by UF/IFAS researchers from around the state as well as growers and industry representatives. The sessions provide up-to-date research and information that will help growers become more competitive in a global economy. This year’s topics ranged from methyl bromide alternatives to opportunities to grow blueberries, blackberries, and peaches in Florida. Educational sessions are grouped by topics so that participants can attend sessions that are of interest to them. This year’s expo included a new session discussing sustainable water use practices in agricultural production. Sessions were moderated by UF/IFAS Vegetable Extension Agents, including Gene McAvoy, Alicia Whidden, and Crystal Snodgrass, as well as Hillsborough County’s Manager of Agriculture Industry Development, Stephen Gran. The agents also provided CEU’s, continuing education units, to pesticide license holders and Certified Crop Advisors for attending each session.

Not only do growers get to hear about current research, they also have an opportunity to see it firsthand. Two field tours were held where participants made stops at selected research sites. The GCREC showcased trials on methyl bromide alternatives, insect and disease management, tomato variety trials, and strawberries and melons grown under high tunnels, a practice that is widely adopted worldwide and has potential for increasing production in Florida.

When not attending sessions or field tours, attendees visited vendor booths where they could see and hear about the latest products available for agricultural production. Non-profit groups like the USDA and the UF/IFAS Small Farms group also set-up booth to interact with participants.

Although the Florida Ag Expo is one action-packed day, it is exciting and informational. It provides growers, researchers, extension agents and vendors opportunities to interact with one another and gather information that may benefit their organization. Before the first Florida Ag Expo took place Tony DiMare said, “I would hope the attendees will find our inaugural event both informative and educational. If the event is successful for all those who have a vested interest, we hope to expand the expo in the future.” This year’s expo boasted 950 attendees; a jump from last year’s 750. This is a tremendous increase from the first Florida Ag Expo when about 400 people attended. The number of vendor booths also increased from 40 in 2008 to 50 in 2009. Tony’s hope has been realized as the Florida Ag Expo becomes one of the most popular agricultural events in Florida. This year the expo went national. Growers from North Carolina, and Washington traveled long distances to attend this unique event. Pictures and presentations from this year’s expo will soon be available at http://gcrec.ifas.ufl.edu/. Planning for next year’s Florida Ag Expo has already begun and will be here before you know it. Be sure to attend.
Dr. Joe Funderburk teaches the audience about Western Flower Thrips Management. (Photo by Jack Rechcigl)

Vendors interact with participants (Photo by Jack Rechcigl)